

DISEASES OF THE BLADDER
PROSTATE GLAND, AND URETHRA

BY THE SAME AUTHOR

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DISEASES OF THE BLADDER

PROSTATE GLAND, AND URETHRA

INCLUDING A

PRACTICAL VIEW OF URINARY DISEASES DEPOSITS AND CALCULI

ILLUSTRATED BY WOOD ENGRAVINGS

BEING

THE FOURTH EDITION OF THE 'IRRITABLE BLADDER'

REVISED AND MUCH ENLARGED

BY

FREDERICK JAMES GANT, F.R.C.S.

(SURGEON TO THE ROYAL FREE HOSPITAL)



LONDON

J. & A. CHURCHILL, NEW BURLINGTON STREET

1876

**"The growth of knowledge is unlike that of other things.
for the more it increases, its bulk diminishes."—ANONYM.**

P R E F A C E

THE Third Edition of my monograph on the "Irritable Bladder" being out of print, both in this country, and in America, I have ventured to take the opportunity of enlarging this Edition into its present form. Considering also the intimate relations which subsist between Diseases of the Bladder, the Prostate Gland, and the Urethra, I have deemed it desirable to associate these three organs together, with regard to their pathology and treatment.

Some eighteen years have elapsed since the last Edition of Mr Coulson's standard work was published—relating exclusively to Diseases of the Bladder and Prostate—and for more than ten years it has been out of print, without a successor among English authors. During that interval, however, the progress of observation and experience has greatly altered and extended the state of pathology and surgery, in this department.

To supply an exhaustive work on this subject,—exhaustive perhaps to the reader also, is beyond my

purpose ; but I have endeavoured to write a Treatise of a *practical* character, respecting the Diseases under consideration ; and generally as verified by my own observation and experience.

Some portions,—the sections on Stone in the Bladder, and *Stricture* of the Urethra, in particular, I have taken from my recent work on the Science and Practice of Surgery ; but they have undergone thorough revision, and much additional detail has been introduced. The Surgical Anatomy of the Bladder, Prostate Gland and Urethra, will be found, I trust, an appropriate Introduction to the Diseases of these Organs, and their Treatment, often by various Operative procedures.

As in previous Editions, this Treatise concludes with a Practical View of Urinary Diseases, Deposits and Calculi ; the Clinical Examination of Urine comprising those ready Tests—chemical and microscopical, with which in relation to these Diseases, every Surgeon should be familiar.

For facility of reference a full Index is appended.

FREDERICK JAMES GANT.

16, CONNAUGHT SQUARE, LONDON, W.;

June, 1876.

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DISEASES OF THE BLADDER, PROSTATE GLAND, AND URETHRA

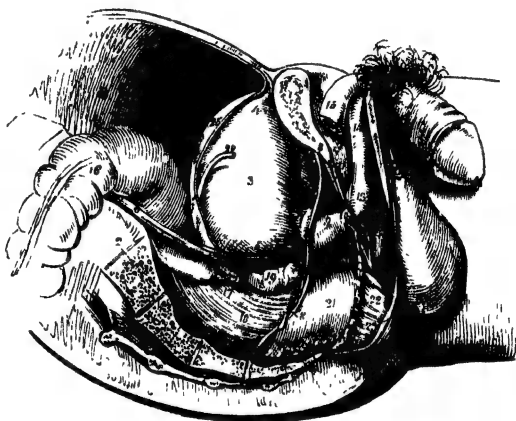
INTRODUCTION

HE who would gain a clear appreciation of the various diseased conditions to which the urinary bladder, prostate gland, and urethra are severally liable, and of their appropriate surgical treatment, must first acquire an accurate anatomical knowledge of these organs, with regard to their structure and surrounding connections, *in situ*, and as described from a surgical point of view. To the practitioner such an introduction to the subject may at least prove serviceable for reference to that knowledge which he must carry with him in the practice of this department of surgery.

URINARY BLADDER.—*Structure*.—The bladder is a musculo-membranous bag or sac, and is richly endowed with blood-vessels, lymphatics, and nerves—sympathetic and spinal. Situated in the pelvic cavity, but during childhood partly in the abdomen, this organ is placed behind the pubes and triangular ligament, in front of the rectum, or of the uterus and vagina, which in the female separate the bladder from the bowel. This hollow organ communicates with the ureters and the urethra; its physiological function being that of a reservoir for the urine, which, as secreted by the kid-

neys, is received through the ureters and retained, until from time to time convenience may permit of the voluntary discharge of that fluid through the urethral canal.

I proceed to a more detailed description of the organ and its relations, as thus defined (Fig. 1).

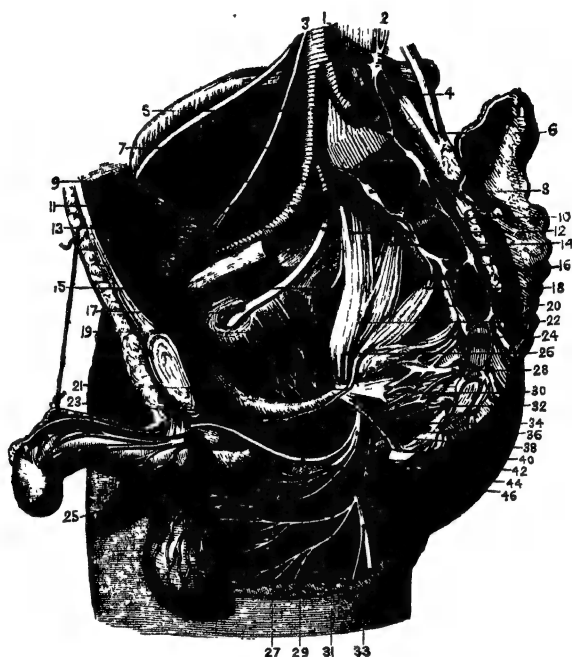


(Wilson.)

FIG. 1.—Side view of the viscera of the male pelvis, *in situ*. The right side of the pelvis has been removed by a vertical section made through the os pubis near the symphysis; and another through the middle of the sacrum.—1. Divided surface of the os pubis. 2. Divided surface of the sacrum. 3. Body of the bladder. 4. Its fundus; from the apex is seen passing upwards the urachus. 5. Base of the bladder. 6. Ureter. 7. Neck of the bladder. 8, 8. Pelvic fascia; the fibres immediately above 7 are given off from the pelvic fascia, and represent the anterior ligaments of the bladder. 9. Prostate gland. 10. Membranous portion of the urethra. 11. Triangular ligament. 12. One of Cowper's glands lying beneath the membranous portion of the urethra. 13. Bulb of corpus spongiosum. 14. Body of corpus spongiosum. 15. Right crus penis. 16. Upper part of first portion of the rectum. 17. Recto-vesical fold of peritoneum. 18. Second portion of rectum. 19. Right vesicula seminalis. 20. Vas deferens. 21. The rectum covered by the descending layer of the pelvic fascia, just as it is making its bend backwards to constitute the third portion. 22. Part of the levator ani muscle investing the lower part of the rectum. 23. External sphincter ani. 24. Interval between the superficial perineal fascia and triangular ligament: they are seen to be continuous beneath the figure.

The bladder may be regarded as essentially a hollow expansion of *mucous membrane* continuous with that of the ureters behind and the urethra in front; the external surface of this sac is overlaid with bands of *muscular fibres*, the unstriped and involuntary variety, disposed in figure-of-8 spiral loops, vertically, obliquely, and horizontally;* springing, for the most part, from the neck of the bladder, to be presently noticed, these muscular bands are thus entwined over and around the organ, leaving intervals of mucous membrane uncovered; a layer of *cellular tissue* intervenes between the two, this submucous texture containing an abundance of the finely coiled fibres of elastic tissue. The muscular arrangement forms the "detrusor urinæ" muscle, and a marked band around the neck of the bladder is named "sphincter vesicæ." *Blood-vessels* are plentifully supplied to the bladder, and have the following distribution:—The internal iliac artery (see Fig. 2), from its anterior division, gives off the *superior* and *inferior vesical* branches, and in the female the *uterine* arteries also, all of which ramify and terminate in the cellular texture and mucous membrane; the *veins* form large *plexuses*, situated chiefly at the neck, sides, and base of the bladder, and, terminating in the internal iliac veins, are accompanied in their course by *lymphatic vessels*, which enter lymphatic glands around the internal iliac artery, and thence proceed upwards to the lumbar glands. *Nerves* are supplied in equal abundance. They proceed partly from the

* Original Dissections by J. Bell Pettigrew, Museum Roy. Coll. of Surgeons Eng., and, same authority, "On the Muscular Arrangements of the Bladder and Urethra," &c., 'Phil. Trans.,' 1867.

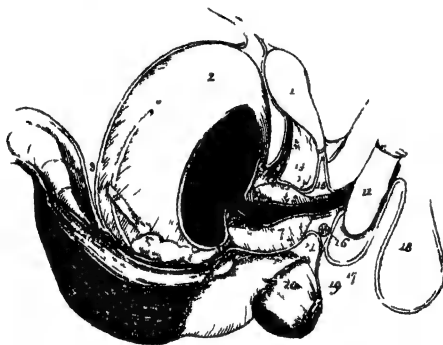


(Hirschfeld and Leverlé.)

FIG. 2. Side-view of the pelvis, showing the nerves, the viscera having been removed.—1. Abdominal aorta. 2. Gangliated cord of sympathetic (left side). 3. Genito-crural nerve. 4. Left common iliac artery. 5. Right common iliac artery. 6. Left lumbo-sacral cord. 7. Psoas muscle. 8. Gangliated cord of sympathetic (right side). 9. Internal iliac artery (cut). 10. Gluteal artery (cut). 11. Right external iliac artery. 12. Right lumbo-sacral nerve. 13. Obturator nerve. 14. First sacral nerve. 15. Gluteal nerve. 16. Piriformis muscle (left side, cut). 17. Obturator artery. 18. Second sacral nerve. 19. Obturator internus muscle. 20. Piriformis muscle (right side). 21. Nerve to levator ani muscle. 22. Sacral plexus. 23. Levator ani (cut). 24. Third sacral nerve. 25. Bulb of urethra overlaid by accelerator urinæ muscle. 26. Nerve to obturator internus. 27. Transversus perinei muscle. 28. Fourth sacral nerve (cut). 29. Dorsal nerve of penis. 30. Visceral branches (cut). 31. Inferior pudendal nerve. 32. Fifth sacral nerve. 33. Small sciatic nerve. 34. Coccygeus muscle. 36. Sixth or coccygeal nerve. 38. Internal pudic nerve. 40. Inferior hæmorrhoidal nerve. 42. Posterior superficial perineal nerve. 44. Anterior superficial perineal nerve. 46. Deep perineal nerves to bulb and muscles.

fourth nerve, or sometimes the third nerve of the *sacral plexus* (Fig. 2), itself derived from the spinal cord, and these *spinal* nerves are distributed to the base and neck of the bladder; but the *hypogastric plexus* from the great *sympathetic* cords (Fig. 2)—a plexus situated between the common iliac arteries—supplies two large prolongations which descend into the pelvis, one on either side, to form two lateral pelvic plexuses, which communicate with a few offsets from the first or two first ganglia in the sacral cord of the sympathetic; and these pelvic plexuses, expanding over the sides of the bladder and rectum, or vagina, are distributed to the upper portion and remaining part of the organ, not supplied from the sacral plexus. Both sets of nerves—spinal and sympathetic—*communicate* in the pelvic plexuses; and the sacral nerves, third and fourth, on either side, contribute branches thereto, aided by a filament or two from the second sacral nerve. Many ganglia are interspersed in each plexus, thus constituted, particularly at the junctions of the spinal and sympathetic nerves. The filaments from either plexus pass along and accompany the branches of the internal iliac artery, given off to the bladder, as already mentioned. The muscular bands, blood-vessels, lymphatics, nerves, and cellular texture, together form a second coat, overlaying the “mucous coat;” while, externally, this “muscular coat” is partially invested with the peritoneum, forming the “peritoneal or serous coat,” which, however, extends over only the posterior half of the bladder, being reflected so as to leave the anterior half of the organ uncovered, or free of this investment.

Ligamentous connections.—The *peritoneum* covering the front of the rectum—or uterus, in the female—is reflected backwards over the posterior part of the under surface or base of the bladder, forming the *recto-vesical* pouch or *cul-de-sac*, in that situation; thence curving upwards and forwards over the posterior surface and adjoining part of each side of the bladder to gain the summit, it is again reflected to either side of the pelvis; and lastly, from opposite the back of the pubes to the wall of the abdomen (Fig. 3). These peri-

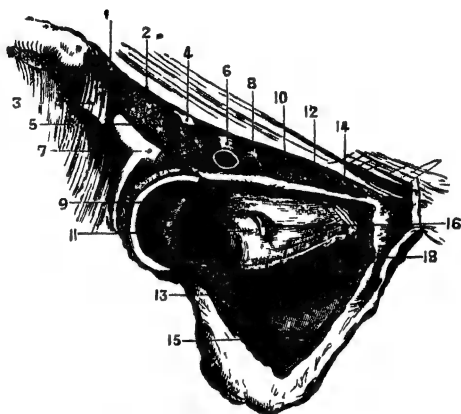


(Wilson.)

FIG 3.—Side view of the viscera of the pelvis in the male, showing the reflexions of the peritoneum.—1. Symphysis pubis. 2. Bladder. 3. Recto-vesical fold of peritoneum, passing from the anterior surface of the rectum to the posterior part of the bladder, and from the upper part of the bladder to the abdominal parietes. 4. Ureter. 5. Vas deferens crossing behind the ureter. 6. Vesicula seminalis. 7, 7, 8, 8 Prostate gland divided longitudinally. 9. Prostatic portion of the urethra. 10. Membranous portion embraced by the compressor urethrae muscle. 11. Commencement of the corpus spongiosum penis, the bulb. 12. Anterior ligaments of the bladder. 13. The pelvic fascia reflected on the rectum. 14. An interval between the pelvic fascia and triangular ligament occupied by a plexus of veins. 15. The triangular ligament. 16. Cowper's gland. 17. Superficial perineal fascia ascending in front of the root of the penis to become continuous with the dartos of the scrotum (18). 19. The fascia prolonged to the rectum. 20. Lower part of the levator ani. 21. A layer of fascia situated between the bladder and rectum.

toneal reflexions are named *false ligaments* of the bladder, and are *five* in number: the portions of peritoneum extending from the back of the pelvis to the bladder, and which bound the recto-vesical pouch, form two *posterior* false ligaments; the lateral reflexions, extending from the sides of the bladder to the pelvis, form two *lateral* false ligaments; and the superior reflexion gives rise to the *superior* or *suspensory* false ligament. But all these so-called ligaments represent one continued reflexion of the peritoneum, as conducted apparently by the course of the internal iliac arteries, and their continuation, the obliterated hypogastric arteries in the adult. Guided by these vessels, and, it may be said, by the ureters, the peritoneum passes forwards along the sides of the middle portion of the rectum to the under surface of the bladder, thence up its sides to the summit, and so to the abdominal wall. In the latter situation, the obliterated *urachus*, a fibro-cellular cord passes from the top of the bladder, in the interval between the two hypogastrics; and with them reflecting the peritoneum upwards, these three cords ascend along the linea alba to the umbilicus. The *true* ligaments of the bladder are prostatic portions of the recto-vesical fascia, on either side of the pelvis; *four* such portions of this fascia, or ligaments, being recognised; two anterior, in front of the prostate, and two lateral, at the sides of that body. Their derivation from the recto-vesical fascia, and their attachments as ligaments of the bladder, may be traced from the *pelvic fascia*. This fascia descends from the brim of the pelvis, and covering the upper part of the

obturator internus muscle, as far as a white line extending between the body of the pubes and the spine of the ischium, the fascial origin of the levator ani muscle (Fig. 4), the fascia there splits into two layers ;



(Heath, drawn by J. T. Gray.)

FIG. 4.—Pelvic fascia, inside view. 1. External cutaneous nerve. 2. Poupert's ligament. 3. Sartorius muscle. 4. Anterior crural nerve. 5. Psoas and iliacus muscles. 6. Femoral artery. 7. Origins of rectus femoris muscles. 8. Femoral vein. 9. Acetabulum, partly removed. 10. Crural ring. 11. Pelvic fascia. 12. Pectineus muscle. 13. Obturator fascia. 14. Gimbernat's ligament. 15. Pudic vessels and nerves in a sheath of fascia. 16. Obturator vessels and nerve. 18. Fascial origin of levator ani muscle (white line).

one layer being continued downwards over the lower part of the obturator muscle, is thence named the *obturator fascia* ; the other layer, inclining inwards and downwards from the white line, passes as a broad expansion, over the upper surface of the levator ani muscle, to the side of the rectum, bladder, and prostate, thus acquiring the name of the *recto-vesical fascia* (Fig. 5). This visceral layer of the pelvic fascia assumes

ligamentous connections in the middle line. Attached to the back of the body of the pubes, just internal to the pubic origin of the levator ani muscle, the fascia, on either side of the pelvis, passes backwards, in front of the prostate to the neck, and adjoining part of the

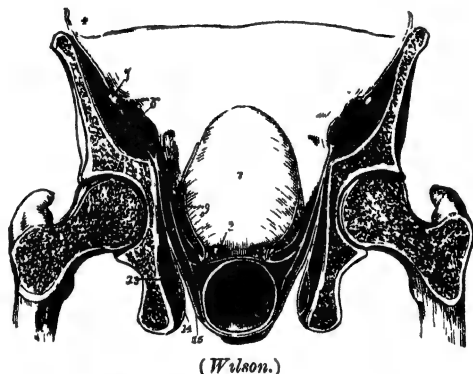


FIG. 5.—Transverse section of the pelvis, *posterior view*, showing the distribution of the pelvic fascia.—1. Bladder. 2. Vesicula seminalis of one side (cut). 3. Rectum. 4. Iliac fascia, covering in the iliacus and psoas muscles (5), and forming a sheath for the external iliac vessels (6). 7. Anterior cervical nerve excluded from the sheath. 8. Pelvic fascia splitting into the rectovesical and obturator fasciæ. 9. Recto-vesical fascia, forming the lateral ligament of the bladder on one side, and a sheath for the vesical plexus of veins. 10. A layer of the fascia passing between the bladder and the rectum. 11. A layer enclosing the rectum. 12. Levator ani muscle. 13. Obturator internus muscle, covered in by the obturator fascia, which also forms a sheath for the internal pudic vessels and nerve (14). 15. Anal fascia investing the under surface of the levator ani.

bladder, in the shape of two roundish, strong, white bands, a right and a left, forming two *anterior* true ligaments; while another portion of the fascia, broader and thinner, passing back on the side of the prostate, to the neck and side of the bladder, forms two *lateral* true ligaments. The anterior true ligaments, therefore,

are better defined; and between the two is a cellular interval, in which lies the dorsal vein of the penis, or clitoris in the female. These bands of the fascia cover in the anterior fibres of the levator ani, the levatores prostatae, which are spread over the prostate, here clos-

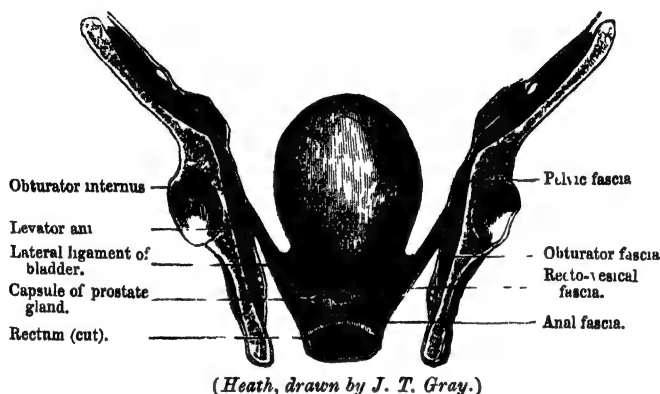


FIG. 6—Transverse section of the pelvis, *anterior* view of the distribution of the pelvic fascia.

ing the outlet of the pelvis; a continuation from the lateral bands completely ensheaths the prostate, as a *capsule* (Fig. 6), an offset of which passing backwards encases the vesiculæ seminales; and the rectal portion of the fascia, from either side, passes inwards between the bladder and bowel, ensheathing the rectum and supporting the bladder; but in its prolongations upwards on these viscera the fascia gradually becomes mere cellular membrane, and is lost in the thin pelvic fascia over the front of the sacrum and pyriform muscle, where the vessels and nerves perforate it to reach the bladder.

The *outlet* of the *pelvis* is closed in by the recto-vesical fasciæ of opposite sides, which, like the levatores ani muscles, form a partition, concave above, convex below; this, however, is perforated by the rectum and prostate, both of which derive sheaths from the membrane in their passage through it. In the *female*, the recto-vesical fascia has the same arrangement, except that besides the rectum, the vagina, instead of the prostate, perforates and is ensheathed by it. By means of the ensheathing prolongations of this membrane, and the corresponding attachments of the subjacent levatores ani muscles, the pelvic viscera are slung in the cavity of the pelvis, with an easy mobility upwards and downwards; as the musculo-membranous floor rises, or descends, these viscera are drawn upwards, or tend to protrude towards the outlet of the pelvis in the perineum.

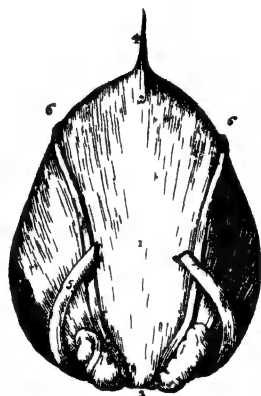
The *relations* of the bladder to surrounding parts are surgically very important.

The *anterior* surface of the bladder, entirely free of peritoneum, is situated behind the body and symphysis of the pubes, and the triangular ligament in the pubic arch. This latter relation of the bladder corresponds to the anterior half of the perineum, in front of the anus; or, in the female, to that smaller part of the vulva which extends between the clitoris and the orifice of the urethra. Above the pubes, the bladder, when distended, rises to the lower part of the abdominal wall. At the lowest part of the anterior surface of the bladder, a narrow funnel-shaped portion, named the *cervix* or *neck*, is surrounded by the prostate gland, a body about

the size and shape of a horse chestnut, which transmits the first or prostatic portion of the urethral canal ; and the prostate, thus standing in front of this part of the bladder, intervenes between this organ and the lower part of the triangular ligament (see Fig. 1).

The *base* or *inferior fundus*, the largest and most dependent portion of the bladder, is directed downwards, and inclined backwards according to the degree of distension ; it rests upon the rectum, its second portion, the vesiculæ seminales and vasa deferentia intervening, and further back, the recto-vesical pouch of the peritoneum. This *cul-de-sac*, broad behind in the interval between the iliac arteries on either side of the rectum, narrows forwards, and is tucked, as it were, under the bladder. In front is a triangular space, where the base of the bladder lies free of peritoneum, and attached to the rectum by the recto-vesical fasciæ ; the apex of this space touches the prostate, its base behind is limited by the peritoneal pouch, and the sides are bounded by the vasa deferentia, and the seminal vesicles outside these tubes, as both converge forwards to enter the prostate gland (Fig. 7). Usually, the *recto-vesical pouch* of peritoneum extends forwards to a point corresponding to about *one inch and a half* from the tip of the coccyx, or about *four inches* distant from the anus ; sometimes, however, the pouch reaches forwards to the prostate, leaving no triangular space uncovered at the base of the bladder. In the *female*, the base of the bladder rests upon the anterior wall of the vagina, and further back on the lower part of the uterus, these organs being placed between the bladder

and rectum. The *utero-vesical* pouch of peritoneum extends forwards only as far as between the *uterus* and bladder, leaving the *vagina* uncovered and adherent to the bladder at the fore part of its base.



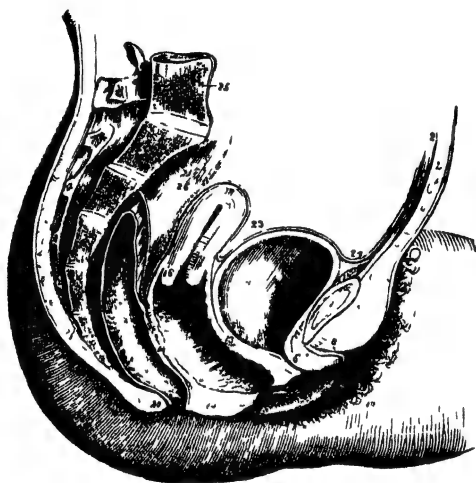
(Wilson.)

FIG 7 —Posterior aspect of the male bladder, the serous covering is removed in order to show the muscular coat —1. Body of the bladder. 2. Fundus. 3. Inferior fundus or base. 4 Urachus. 5, 5. Ureters. 6, 6. Vasa deferentia. 7, 7 Vesiculæ seminales. The triangular area, bounded by the vasa deferentia and vesiculæ seminales at either side, a dotted line above, and the figure 3 below, is the space corresponding with the trigonum vesicæ. It is this part of the bladder which is pierced, in puncturing the bladder through the rectum. The dotted line, forming the base of this triangular area, marks the extent of the recto-vesical fold of peritoneum

The *posterior* surface of the bladder is in contact with the rectum, or, in the *female*, with the uterus; but this surface of the bladder is covered entirely by the peritoneum, reflected upwards from the rectal, or uterine, *cul-de-sac* (Fig. 8).

The *sides* of the bladder are each crossed obliquely from behind by the cord of the obliterated hypo-

gastric artery, passing forwards and upwards to the summit of the organ. Behind and above this cord, the peritoneal investment of the posterior surface is prolonged forwards over the sides of the bladder; but in



(Wilson.)

FIG. 8.—Female pelvis and side view of the viscera.—1. Symphysis pubis. 2. Abdominal parietes. 3. Mons Veneris. 4. Urinary bladder. 5. Orifice of the left ureter. 6. Canal of the urethra. 7. Meatus urinarius. 8. Clitoris, with prepuce, divided through the middle. 9. Left nympha. 10. Left labium major. 11. Meatus of the vagina, narrowed by the contraction of its sphincter muscle. 12, 22. Canal of the vagina, showing also the transverse rugæ. 13. Thick wall between the base of the bladder and the vagina. 14. Thick wall between the vagina and the rectum. 15. Perineum. 16. Os uteri. 17. Cervix uteri. 18. Fundus uteri. 19. Rectum. 20. Anus. 21. Upper part of the rectum, with its investment of the peritoneum. 23. Utero-vesical fold of the peritoneum. The recto-vaginal fold is shown between the rectum and the posterior wall of the vagina. 24. Superior false ligament of the bladder. 25. Last lumbar vertebra. 26. Sacrum. 27. Coccyx.

front of the cord, which reflects the peritoneum, the sides are uncovered, being, however, here supported by an expansion of the recto-vesical fascia. This

otherwise uncovered portion of the bladder, on either side, is in immediate relation to the *ureter* which transmits the urine from the kidneys into the bladder, and the *vas deferens* or excretory duct of the testis (Fig. 1). The ureter, a tube like a white band, having descended into the pelvis across the common or the external iliac artery, it curves downwards, forwards, and inwards in the posterior vesical ligament, arching *below* the obliterated hypogastric artery, to gain the lateral aspect of the base of the bladder, which it enters about two inches and a half from the prostate gland, and rather less than that distance from the ureter on the opposite side; the tubes penetrate the coats of the bladder obliquely for nearly an inch, passing through the muscular coat and then between it and the mucous coat, to open upon the inner surface of the bladder by two oblique slit-like apertures. The *vas deferens*, a small round cord-tube, one on each side, having entered the abdomen through the internal abdominal ring, this cord curves backwards and downwards on the side of the bladder, to near its posterior surface, then crossing the hypogastric artery and the ureter on the *inner* side of that tube, the cord turns forwards along the base of the bladder, lying to the inner side of the seminal vesicle, where, becoming enlarged and sacculated, the *vas deferens* enters the base of the prostate gland, there joining with the duct of the seminal vesicle to form the common ejaculatory duct. The *vesiculæ seminales* (Fig. 1), one on each side, are narrow, club-shaped, sacculated bodies, the large end being directed backwards, and extending to about two and a half inches in length. Consisting of a convo-

luted tube, encased in an offset of the prostatic portion of the recto-vesical fascia, each vesicle lies on the outer side of the vas deferens, and converges from behind forwards to the prostate.

In the *female*, the ureters pass along the sides of the cervix uteri and upper part of the vagina to reach the bladder; and the vasa deferentia, vesiculæ seminales, and prostate gland, are absent.

The *summit* or *superior fundus* of the bladder, covered behind by peritoneum, is free in front, where that membrane is reflected upwards to the abdominal wall by the three cords already mentioned, namely, the two obliterated hypogastric arteries, and the urachus in an interval between them; this anterior and uncovered portion of the summit looks towards the abdominal wall above the pubes. Convolutions of the small intestine rest upon the top of the bladder, and sink down behind its posterior surface into the peritoneal pouch, recto-vesical, or utero-vesical, *cul-de-sac*.

Internal surface of the bladder.—The inner surface of the *mucous coat* of the bladder presents certain characters worthy of notice, and some peculiarities which mark the interior.

The mucous membrane is soft, and smooth, and of a pale rose colour; it is studded with minute follicles, most numerous near the neck of the bladder, and the whole surface is covered with a spheroidal epithelium. The vesical mucus has, it is said, an alkaline reaction, and contains alkaline and earthy phosphates. The membrane—having these characters—is loosely attached

to the muscular coat, by means of the sub-cellular layer; so that when the bladder is empty, the surface generally is thrown into small internal folds or wrinkles, and when distended, there is some tendency to protrusion in the intervals of the muscular bands.

The *inferior fundus* is the most capacious and dependent part of the bladder; in front, it presents a small triangular space,—the *trigone vesical*; situated immediately behind the orifice of the urethra, the apex of this space is directed forwards to that orifice, and the base is a transverse line slightly curved forwards, between the orifices of the two ureters, which form the posterior angles of the space; while the sides are marked by two linear ridges passing obliquely backwards and outwards from the urethra to the ureters, and which correspond to two small fasciculi of muscular fibres,—the muscles of the ureters, lying under the mucous membrane. These muscles arise from behind the middle lobe of the prostate, and pass to the oblique slit-like openings of the ureters; they may, therefore, so act upon these openings, as to maintain their obliquity and thus prevent any reflux of urine into the tubes; or, by drawing their apertures downwards, may facilitate the flow of urine into the bladder. The trigone—having the boundaries already noticed—corresponds to the triangular space at the *base* of the bladder, which lies between the prostate in front, and the peritoneal pouch behind, bounded laterally by the vasa deferentia and vesiculæ seminales; but the triangular space within the bladder is of even more limited extent, measuring from the apex

backwards about one inch and a half, and between the two posterior angles,—at the orifices of the ureters, from that to two inches transversely. The surface of this space is smooth, the mucous membrane being somewhat thinner than elsewhere, and adherent to the subjacent texture; thus never presenting any little folds, even in an empty state of the bladder. But this area in the inferior fundus is the most sensitive portion of the whole interior. In front of the apex of the trigone a small transverse prominence appears—the *uvula vesicae*,—formed by a thickening of the sub-mucous tissue; this elevation is placed just before the middle lobe of the prostate, and projecting from below into the urethral orifice, it partly closes the aperture; and is sometimes continued forwards as a slighter elevation on the floor of the prostatic portion of the urethra. Adjoining the orifice of the urethra, the bladder becomes narrowed into a funnel-shaped portion,—the *cervix* or *neck*,—within which the mucous membrane is disposed in longitudinal folds. In the *female* the trigone is a smaller space, the muscles of the ureters are less developed, and the uvula is indistinct.

Size, Shape, Position, and Relations of the Bladder, as altered by the State of Distension.—The surgical anatomy of the bladder varies in certain important particulars, according to the state of collapse or distension of this organ. When entirely *empty*, after the complete evacuation of urine, it is reduced to its minimum size, and it then has the shape of a triangular sac, flattened in front and behind; its base is directed downwards, resting on the rectum, and the

apex reaches upwards to behind the symphysis pubis, so that the sac lies against the triangular ligament, and sunk down entirely within the cavity of the pelvis. When *moderately* distended,—as was supposed in describing the relations of the bladder,—this sac assumes a circular form, with the corresponding dimensions of about three inches in width and five inches in length, the organ holding about a pint; but its axis remains nearly vertical, and it is still contained within the pelvic cavity. When *fully* distended, the bladder acquires an ovoidal or egg-shaped form, curved also somewhat, and compressed, from behind forwards, thus becoming slightly concave in front and widened from side to side; the organ has rotated on its transverse axis, the base being directed downwards and backwards on the rectum, or vagina, and the summit looking upwards and forwards,—its long axis, therefore, inclining in an oblique line drawn from the coccyx to some point between the pubes and the umbilicus; the bladder rises in the direction of this line, out of the pelvis, until its summit touches the wall of the abdomen above the pubes, in the hypogastric region, at a height varying according to the state of distension. This elevation of the bladder proceeds from the neck, which, owing to its true ligamentous attachments, and connection with the urethra, is a tolerably fixed point. The funnel-shaped outlet still remains the lowest portion in front, but it is elevated relatively to the prostate, the inferior fundus also rising to a higher level, is relatively less dependent; while externally, the peritoneal pouch recedes to some extent from the

base, thus presenting a larger triangular space against the rectum, and the summit of the bladder, in front of the superior peritoneal false ligament, is more exposed, or comes in contact with the wall of the abdomen above the pubes.

The *age* of the subject examined must not be overlooked in noticing the relative anatomy of the bladder.

In *infancy* and *youth*, the neck is the lowest portion of the bladder,—lower than the inferior fundus; the prostate, in front, around this portion, is of much smaller size or rudimentary; and the bladder lies partly in the cavity of the pelvis, but projecting upwards more or less above the brim into the hypogastric region.

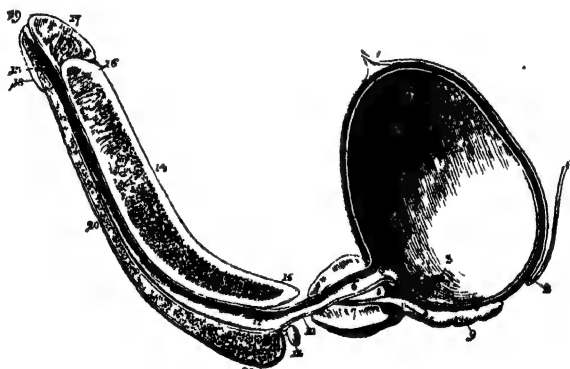
In *old age*, on the other hand, the inferior fundus is even more capacious and dependent than in the adult, and any enlargement of the prostate will increase this proportionate difference; so that if the finger be introduced through the neck of the bladder, as in lithotomy, the fundus is felt inclining downwards, and as the prostate projects upwards, the finger must be hooked downwards to reach the fundus.

In the *female*, the prostate being absent, the inferior fundus is less relatively dependent below the neck of the bladder, but the capacity of the whole organ is perhaps larger than in the male; and its width from side to side is greater than its height from base to summit, which is the longer diameter in the male subject.

PROSTATE GLAND.—By an intimate association, both pathological and surgical, we are led from the anatomy of the bladder to consider the structure and relations

of the prostate gland. We proceed therefore to notice, successively, the situation, shape, size, position, and relations of this organ ; then, its structure, and lastly, the prostatic portion of the urethra.

The prostate, an organ peculiar to the male subject, is a firm glandular body, *situated* at the neck of the bladder, which it surrounds, and the commencement of the urethra passes through it (Fig. 9). This body is



(Wilson.)

FIG. 9.—Longitudinal section of the bladder, prostate gland, and penis
 1. Urachus. 2. Recto-vesical fold of peritoneum. 3. Orifice of the right ureter. 4. Slight ridge formed by the muscle of the ureter. 5. Neck of the bladder. 6. Prostatic portion of the urethra. 7. Prostate gland. 8. Common ejaculatory duct. 9. Right vesicula seminalis; vas deferens cut short. 10. Membranous portion of the urethra. 11. Cowper's gland of the right side, with its duct. 12. Bulbous portion of the urethra. 13. Fossa navicularis. 14. Corpus cavernosum. 15. Right crus penis. 16. Portion of the septum pectiniforme. 17. Glans penis. 18. Corona glandis. 19. Meatus urinarius. 20. Corpus spongiosum. 21. Bulb of the corpus spongiosum.

placed deep in the cavity of the pelvis, and looking towards its outlet in the perineum ; it lies below the symphysis pubis by half an inch or more, and behind the triangular ligament at its lowest part ; standing in

front of the neck of the bladder, adjoining its base, the prostate thence derives its name (*προϊστημι*, to stand before); and beneath it rests on the middle portion of the rectum, just above the terminal portion,—about the depth of one inch and a half from the anus, where the bowel turns downwards to the anal aperture. Here, therefore, the prostate is accessible from the surface in the perineum.

The shape and size of this body resemble the form and dimensions of a horse-chestnut. Its *shape* is that of a truncated cone, compressed from above downwards; the base being turned backwards to the bladder, and the blunt apex forwards to the triangular ligament and the membranous portion of the urethra. The anterior, or upper, surface,—according to the position of the body,—is somewhat convex, and marked by a slight median groove; the under surface is larger and flattened, it also presents a median furrow, thus indicating a division of the gland into two lateral lobes. The base of the prostate, its thickest part, is notched in the middle and under aspect of the gland; and this posterior notch receives the common ejaculatory ducts, above which, and in the interval between the lateral lobes, is placed a small rounded or triangular portion of the gland,—the third or middle lobe, transversely connecting the two lateral lobes, and which lies beneath the neck of the bladder, just behind the uvula and the adjoining commencement of the urethra. The sides of the prostate are convex, and the apex is truncated. In respect to the *size* of this body, it varies so much according to the

age of the subject, that the average dimensions must be taken as found in the adult. The measurements in three different directions may thus be stated: from apex to base, one inch or rather longer; transversely at the base, its widest part, about one inch and a half; and in depth or thickness, about one inch or rather less. Consequently, an incision having an oblique direction downwards and outwards, from apex to base, in the lateral part of the gland, will be the longest section of which the prostate admits. But in infancy and youth, the gland is rudimentary or of small size, whereas, after middle-life and in old age, it may undergo considerable enlargement. The weight of this body averages from half an ounce to an ounce; but this, like its size, varies with the period of life, and in different individuals of the same age.

The *position* of the prostate, or its attitude, must necessarily change, with the position of the pelvis,—in the recumbent or the erect state of the body. When recumbent, the pelvis has that position in which, a line drawn through the prostate, from apex to base, would be directed obliquely downwards and backwards; the upper surface inclining backwards, and the lower surface somewhat forwards, the more so as the pelvis is elevated; and this corresponds with the position in which the prostate is generally submitted to surgical examination, or operation, in connection with the bladder. In the erect state of the body, the axial line of the prostate falls from the oblique to nearly a horizontal direction; and when the trunk is inclined forwards, so as to present the fundament

backwards, the prostate, its under surface, turns with it in the latter direction,—thus corresponding to the position in which the gland may be examined with the finger through the rectum.

Certain *relations* of the prostate to surrounding parts have already been noticed incidentally, with reference to the neck of the bladder, the pelvic cavity, and the rectum. Thus, the base of the gland, around the neck of the bladder, receives also the common ejaculatory ducts, and it limits in front the triangular space which is free of peritoneum at the base of the bladder; the apex of the gland touches the triangular ligament and the membranous portion of the urethra, in the pubic arch, about half an inch below the pubes; and its under surface rests upon, and is closely adherent to, the rectum, just above its terminal portion, which turns downwards to the anus. This under surface of the prostate, and its base, may be felt by introducing the finger through the anus into the bowel. The remaining surfaces have special relations to the recto-vesical fascia. Thus, the upper surface of the prostate, below the pubic symphysis, is covered by the two strong, roundish bands, which form the anterior true ligaments of the bladder, with the dorsal vein of the penis lying between them; while the sides of the gland are covered by the broad and membranous lateral true ligaments of the bladder.

But in addition to these fascial prolongations, thus disposed, the remainder of the prostate receives an investment from the same fascia; forming altogether a complete sheath or capsule which envelopes the gland

(Fig. 6). External to this capsule, the sides of the prostate are overlaid by the anterior fibres of the levatores ani muscles, one on each side ; which passing down from the symphysis pubis, and spreading over the sides of the gland, unite together in front of the rectum, in the central tendinous point of the perineum with the fibres of the external sphincter of the anus. Thus the prostate is slung by the levatores ani muscles, just as the rectum, and the vagina in the female, are also slung by these muscles ; and these anterior portions of the muscular fibres, which are sometimes defined by a cellular interval, have been named *levatores prostatae*. In old persons, the rectum may have become much dilated above the anus, forming a pouch, which rises up and wraps around either side of the prostate, so as to enclose this body, except at its upper surface.

The *structure* of the prostate gland was so far noticed in describing the shape of this organ, that it was seen to consist of three lobes ; two lateral, of equal size, separated only by a median furrow on the upper and lower surfaces of the gland, and by a notch at the base ; within which interval is placed the middle or third lobe. The mass of the gland, having this lobed arrangement, is encapsuled within a fibrous coat, consisting of two layers ; an external dense layer, or an ensheathing prolongation from the recto-vesical fascia, as already mentioned ; and an inner, thin, membranous investment, which sends processes into the interior of the gland, supporting its substance. Between these two layers of the *capsule*, a *plexus of veins*, the prostatic plexus, is enclosed. The substance

of the gland has a reddish or brownish colour; its texture is spongy or firm to the touch, although not so dense as when felt through the fibrous coat, with perhaps also the thickness of the rectum intervening; and it yields or lacerates under pressure with the finger,—splitting in the direction of its grain, the prostatic ducts, as when, in the operation of lithotomy, the prostatic incision is enlarged by introducing the finger into the bladder. The glandular substance consists of numerous, small terminal follicles, which, in the form of clusters, surround and open into the elementary ducts; these, having a branched arrangement, unite into the excretory ducts, about twelve to twenty in number, which open by as many orifices upon the floor of the prostatic portion of the urethra. The epithelium in the follicular terminations is squamous, and in the ducts, columnar. Section of the gland shows the ducts, which appear as white lines or minute apertures, according to the direction of their division. Richly supplied with blood-vessels, the arteries are branches of the vesical, hæmorrhoidal, and pudic arteries, which passing into the substance of the gland ramify and form a capillary network around the ducts and clusters of follicles; the prostatic veins form a plexus around the gland, between the two layers of its fibrous capsule, and this venous plexus communicates in front with the dorsal vein of the penis, but behind with the plexus of veins at the neck, base and sides of the bladder, thence passing into the internal iliac veins. This continuous plexus of veins,—prostatic and vesical,—becomes enlarged in old subjects,

and is often the source of troublesome hæmorrhage when wounded in lithotomy. Lymphatic vessels, with the veins, ramify beneath the dense external layer of the fibrous capsule. Nerves are derived from the pelvic hypogastric plexuses on either side of the bladder, prolongations from which form the *prostatic plexus of nerves*.

The *prostatic fluid*, or secretion of the gland, mixed with the seminal fluid, is discharged in the act of emission. But the nature of this fluid in itself, is not well known. After death, when fresh, it has a milky white tint, an acid reaction, and abounds with granular matter and epithelial particles, squamous and columnar.

URETHRA.—The urethra is a membranous tube, which extends from the neck of the bladder to the end of the penis. The length of this tube averages nine or ten inches, when the penis is flaccid, but admits of some elongation during erection of this organ; the diameter of the tube varies in different parts, being about a quarter of an inch at its widest part,—the centre of the prostate. The urethral tube consists of mucous membrane, with an outer layer of sub-mucous cellular and elastic tissue; but it is supported also by the structures through which it passes, and by certain muscular expansions. Lying in the middle line, the urethra passes from the bladder through the substance of the prostate gland; then, becoming simply membranous, the tube penetrates the triangular ligament, under the arch of the pubes; where, entering the spongy structure of the penis, it is continued to the end of the glans and opens externally as

the *meatus urinarius*. The *direction* of the urethral canal, in its course forwards, is that of a double curve; the prostatic and membranous portions, and the commencement of the spongy portion, or its bulbous part, together form a curve, downwards, forwards, and upwards to the front of the pubes; from which point, the remainder of the spongy portion descends in the penis. This double curve, however, depends upon the state of the penis; for when this organ is erect, or raised upwards towards the pubes, the second curve forms with the first, a single curve, thus continuing the concavity of the curve upwards. The urethra performs the excretory function of transmitting and discharging the urine from the bladder; but it also transmits the seminal fluid in sexual intercourse.

The three portions of the urethra, already indicated, each demands a separate notice.

The *prostatic* urethra is that portion of the tube which extends from the vesical orifice to the membranous portion, about a line behind the triangular ligament,—its posterior layer. This portion of the urethra passes through the prostate gland, from base to apex; lying at first above the middle lobe, and afterwards nearer to the upper than to the lower surface of the gland, by about two thirds of its substance below the urethra. The common ejaculatory ducts also converge under the base of the prostate, forwards and upwards, lying side by side for about an inch, between the middle and lateral lobes, and then pass through the gland to open on the floor of the prostatic urethra. This portion of the urethra has a fusiform or spindle shape, being

widest in the middle, and constricted somewhat before and behind (Fig. 10). Its length is about one inch and



(Wilson.)

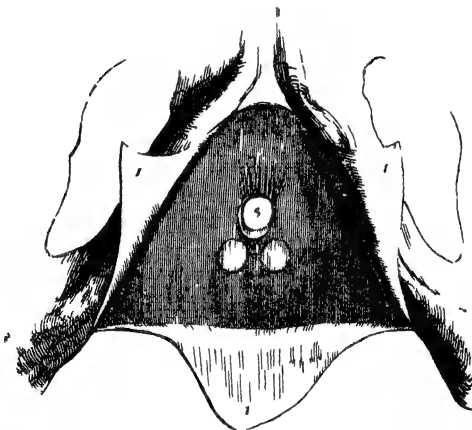
FIG. 10.—Urethra, showing the bulbous, membranous, and prostatic portions, with part of the bladder, laid open from above. 1. Lower part of the bladder. its internal surface. 2. Trigone vesical. 3. Orifices of the ureters. 4. Uvula vesicae. 5. Veru montanum. 6. Opening of the sinuo-pocularis. 7, 7. Aper- tures of the ejaculatory ducts. 8, 8. Openings of the prostatic ducts in the prostatic sinus. 9, 9. Lateral lobes of the prostate gland. *a*. Membranous portion of the urethra. *b, b*. Cowper's glands. *c, c*. Openings of the ducts of Cowper's glands. *d*. Commencement of the bulbous portion of the urethra. *e, e*. Upper surface of the bulb of the corpus spongiosum. *f, f*. Crura penis. *g, g*. Corpus cavernosum. *h*. Spongy portion of the urethra.

a quarter ; its breadth behind, at the neck of the bladder, is about a quarter of an inch, in the middle, it widens to a line or two more, and in front, at the commence- ment of the membranous urethra, the canal narrows again to rather less than behind. It is the widest and most dilatable portion of the whole urethral

canal, although least extensible at the neck of the bladder. The mucous membrane of the prostatic urethra presents slight longitudinal folds, in a collapsed state of the passage ; but a median ridge of mucous membrane and thickened sub-mucous tissue projects in the floor of the urethra ; extending from just in front of the little elevation, *uvula vesicæ*, at the vesical orifice, and, gradually rising to a peak, it subsides rather abruptly towards the membranous urethra. This ridge is about three quarters of an inch in length, but only a line and a half in depth, at its highest point. It is variously named ; the *crest* of the urethra, or *crista urethræ* ; more commonly, *caput gallinaginis*, or *veru montanum*. On either side lies a depressed portion of the canal, the *prostatic sinus*, in the form of a longitudinal groove, and somewhat deeper behind at the vesicle orifice ; the floor of either sinus is beset with numerous small apertures, the openings of the prostatic ducts from the lateral lobes, while those of the middle lobe open behind the central crest. In the crest, just in front of its peak, a small recess or *cul-de-sac* passes downwards and backwards between the lateral lobes, and beneath the middle lobe ; at its orifice in the urethra, this *cul-de-sac* is about a line in width, but it enlarges to double that size at its fundus, a depth of about a quarter of an inch. This recess in the central crest is usually named the *sinus pocularis* ; also the *vesica prostatica*, or the *utricle*, as being probably the analogue of the uterus in the female. It receives the two common ejaculatory ducts, which open by two narrow slit-like apertures upon or within the margins of the *cul-de-sac*, one on either side, or sometimes at

the bottom of the fundus. Numerous small glands also open within this recess; and the crest has been found to contain erectile tissue, whereby, perhaps, when distended with blood, this central eminence may prevent any retroversion of semen into the bladder.

The *membranous* urethra reaches from the apex of the prostate to the bulb of the corpus spongiosum. It passes through the double membranous layer of the triangular ligament in the pubic arch, about an inch below the symphysis (Fig. 11), but this portion of the



(Wilson)

FIG 11 —The pubic arch and perineal fascia 1, 1, 1 The superficial perineal fascia divided by a Δ -shaped incision into three flaps the lateral flaps are turned over the ramus of the pubes and ischium on either side, to which they are firmly attached, the posterior flap is continuous with the deep perineal fascia or triangular ligament 2 The triangular ligament of Camper. 3 Opening for the passage of the membranous portion of the urethra, previous to the entrance of the latter into the bulb 4 Two projections of the triangular ligament corresponding with the position of Cowper's glands

urethra extends backwards for about a line behind the ligament, to the apex of the prostate, and forwards, a

little in front, to the bulb. Having a curved direction upwards, the greatest length of the membranous urethra measures not more than three quarters of an inch in the concavity, the convexity is even less, being overlaid by the bulb in front; and its diameter is less than that of any other portion of the urethra. The tube here lies over the end of the rectum, but separated by a cellular interval, where the bowel turns downwards; above, the dorsal vessels and nerve of the penis penetrate the triangular ligament; between the two layers of this ligament, the membranous urethra is embraced by the *compressor urethræ* muscle (Fig. 12), consisting of two layers of transverse muscular fibres, one above, and one below the tube, attached to the ramus of the pubes on either side, and some



FIG. 12.—Posterior view of the pubes, with part of bladder and urethra attached. 1 Body of pubes. 2. Ramus. 3 Obturator internus muscle. 5. Portion of the fundus and neck of the bladder laid open. 6. Prostate gland. 7. Transverse fibres of the *compressor urethræ*, passing above the urethra 8. Similar fibres passing beneath the canal.

circular muscular fibres surround this part of the urethra. Just beneath, and under cover of the lower band of fibres, are situated Cowper's glands ; two little bodies, like peas, of a yellow colour, one on either side ; above, lie the arteries of the bulb, one on either side,—about half an inch above the base of the ligament.

The *spongy* portion of the urethra extends from the membranous part, at the bulb, to the external orifice, at the end of the glans penis. Continuing the curve of the membranous urethra up to the symphysis pubis, and then descending in the pendent penis, on its under surface, this portion of the urethra is enclosed in the corpus spongiosum. It is the longest portion of the whole urethra, measuring six inches, more or less, according to the length, and state of the penis ; its diameter is somewhat dilated in the bulb,—as the *bulbous sinus*, and again in the glans,—forming the *fossa navicularis* ; and in both these parts, the floor of the passage is most dilated. In the interval between these dilatations, the spongy urethra is of smaller size, about three lines in diameter ; and at the external orifice, the urethra is even more contracted, that being the narrowest point of the whole tube.

In the course of the urethral canal, it should be observed that its size or *diameter* varies ; there are *three dilated* parts ; the *prostatic sinus*, the *bulbous sinus*, and the *fossa navicularis* in the glans penis, and of these, the first named is the widest part of the whole canal ; other parts are more or less narrow, and the narrowest is the external orifice in the glans. The *form* of the canal is of less practical consequence, but a

section differs in different parts of its extent ; in the prostate, it has a triangular shape, with the apex downwards ; in the membranous, and spongy portions of the passage, a transverse opening,—except in the glans, and at the urethral orifice, which presents a vertical fissure opening,—*meatus urinarius*.

The *mucous membrane* of the urethra is a prolongation of the genito-urinary ; being continuous with that of the bladder, ureters, and kidneys, and with offsets lining the prostatic and ejaculatory ducts. The ducts of Cowper's glands pass forward in the membranous portion, beneath the mucous membrane, to the extent of an inch or more, and open by two oblique pin-hole apertures, in the floor of the bulbous portion of the urethra, at its fore part. The urethral mucous membrane has a reddish colour, but is paler in the prostatic portion ; throughout its course this membrane is loosely connected by sub-mucous tissue to the corpus spongiosum or erectile structure which encloses the tube ; so that the mucous surface of the membrane presents longitudinal folds, which, however, are effaced when the canal is dilated during micturition or by the passage of an instrument. Numerous mucous follicles and lacunæ stud the surface, especially along the *floor* of the urethra, and in the bulbous part ; but, the largest,—*lacuna magna*, is situated in the fossa navicularis, on its upper surface. These openings are directed forwards, towards the outer urethral orifice ; a larger one than usual may, therefore, offer some hitching impediment to the passage of a small-sized instrument along the urethral canal.

The *corpus spongiosum* is that erectile structure which surrounds the urethra, from the end of the membranous portion to the external orifice of the urethra. Commencing just in front of the triangular ligament,—rather behind the converging crura of the corpora cavernosa, which chiefly form the body of the penis—the corpus spongiosum appears in the shape of a flattened ovate extremity—the *bulb*, projecting backwards beneath the membranous urethra, in front of the triangular ligament; continued forwards as a cylindrical investment of the urethra, the corpus spongiosum lies in a groove or furrow on the under surface of the corpora cavernosa, at their junction in the middle line; but at their anterior truncated end, the spongy body enlarges over them and forms the glans penis. Around the vertical orifice of the urethra, the erectile structure forms two small lips, which when turgid with blood, as from congestion of the mucous membrane, constrict the urethral orifice to a smaller size than even in its usual state.

The *muscles* of the urethra and penis are; the accelerator urinæ or ejaculator seminis, the compressor urethræ, already noticed, and the erector penis.

The *accelerator urinæ* has an important relation to the urethra. This muscle is a flat expansion of muscular fibres under, and around the urethra, or corpus spongiosum, and extending from the bulb to the junction of the corpora cavernosa, at the converging crura (Fig. 13). The muscle arises from the central tendinous point of the perineum, situated just below the bulb of the urethra—a point which also

gives attachment to the sphincter ani, and to the two transverse muscles of the perineum; from this point, a tendinous raphé, in the middle line, gives rise to fleshy fibres, thus forming a symmetrical bipartite muscle, which overlays the bulb and adjoining part of the corpus spongiosum; the two halves of the muscle, for the most part, pass round the spongy urethra, and are united



(Wilson.)

FIG. 13.—Muscles of the perineum. 1. Acceleratores urinæ; the figure rests on the corpus spongiosum penis. 2. Corpus cavernosum of one side. 3. Erector penis of one side. 4. Transversus perinei of one side. 5. Triangular space, through which the triangular ligament is seen. 6. Sphincter ani; its anterior extremity cut off. 7. Levator ani of the left side; the deep space between the tuberosity of the ischium (8) and the anus, is the ischio-rectal fossa; the same fossa is seen on the opposite side. 9. Spine of the ischium. 10. Left coccygeus muscle. The boundaries of the perineum are well exhibited in this engraving.

above by a tendinous aponeurosis; but a band of anterior fibres, on either side, embraces the corpus cavernosum, at the junction of the crus, and are inserted into a fascia on the dorsum of the penis, over the dorsal vessels and nerve. The action of the urethral

portion of this muscle is to expel any fluid, urine or semen, from the urethra, at the same time aiding in maintaining the turgescence of the glans penis; while the two penile bands of fibres will aid in maintaining the erectile state of the whole organ.

The *arteries* of the penis are branches of the internal *pudic* artery (Fig. 14); namely, the two arteries of the

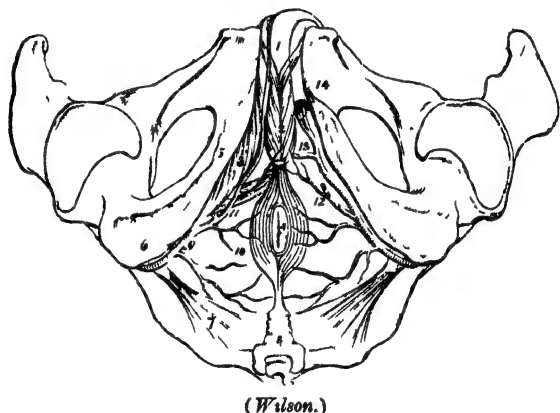


FIG. 14.—Arteries of the perineum. Superficial arteries on the right side; deep arteries on the left. 1. Penis; crus penis of the left side cut. 2. Accelerator urinæ muscle. 3. Erector penis muscle. 4. Anus, with sphincter muscle. 5. Ramus of ischium and pubes. 6. Tuberosity of ischium. 7. Small sacro-sciatic ligament. 8. Coccyx. 9. Internal pudic artery, crossing the spine of the ischium and entering the perineum. 10. Inferior hæmorrhoidal branches. 11. Superficialis perinei artery, giving off the transverse artery upon the transversus perinei muscle. 12. The same artery on the left side, cut. 13. Artery of the bulb. 14. Artery of the corpus cavernosum and the dorsal artery of the penis.

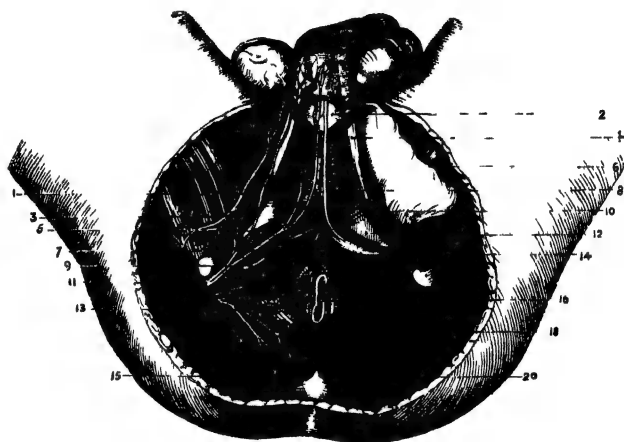
bulb, distributed to the erectile structure of the corpus spongiosum, the dorsal artery, supplying the glans penis, and the two arteries of the corpora cavernosa, distributed to the erectile structure of these bodies,

which constitute the body of the penis. The arterial vessels having penetrated the fibrous coat of the spongy and cavernous bodies, they ramify as a capillary network, supported by fibrous prolongations from the sheath, or trabeculæ; which, in the shape of bands and cords, in all directions, across the sheath, leave inter-trabecular spaces. A median fibrous partition,—*septum pectiniforme*, separates the two corpora cavernosa; but the comb-like clefts of this septum, passing from the dorsal to the urethral margin, allow a free vascular intercommunication, except at the root of the penis where the septum is entire. Companion *veins* to each of the two pairs of arteries, form venous plexuses, which occupy the inter-trabecular spaces, in the spongy and cavernous bodies; but the veins in the spongy structure do not communicate with those of the cavernous structure; the inter-trabecular veins, for the most part, emerge from the bulb, and cavernous bodies, at the root of the penis, and enter the prostatic plexus; while the dorsal vein, coming from the glans, and lying with the artery in the groove on the back of the penis, also enters the prostatic plexus of veins.

Lymphatics proceed from the urethral mucous membrane, that of the glans also, and from the skin of the prepuce, as a net-work, from which emergent vessels enter the inguinal lymphatic glands; but some *deep* lymphatics, from the spongy and cavernous bodies, pass under the pubic arch to the lymphatics in the pelvis.

Nerves are supplied to the penis, corresponding to the arteries. They are derived from the *pubic* nerve, a branch

of the sacral plexus of spinal nerves ; and from the *prostatic plexus* of nerves, an offset of the hypogastric plexus of the sympathetic. Thus, from the *pudic* nerve (Fig. 15) proceeds the dorsal nerve, distributed to the glans, but also supplying a large branch to the corpus cavernosum on each side, and integumental branches to the prepuce, dorsum and sides of the penis. The two superficial



(Heath. Drawn by J. T. Gray)

FIG. 15.—Superficial view of the male perineum. 1. Inferior pudendal nerve. 2. Urethra. 3. External or posterior superficial perineal nerve. 4. Crus penis. 5. Superficial perineal artery. 6. Deep layer of superficial fascia (reflected). 7. Internal or anterior superficial perineal nerve. 8. Accelerator urinæ muscle. 9. Muscular branches of the pudic nerve. 10. Erector penis muscle. 11. Pudic artery and nerve. 12. Triangular ligament, or deep perineal fascia. 13. Inferior hæmorrhoidal artery and nerve. 14. Reflection of the deep layer of the superficial perineal fascia around the transversus perinei muscle. 15. Branch of the fourth sacral nerve. 16. Sphincter ani muscle. 18. Levator ani muscle. 20. Gluteus maximus muscle.

perineal nerves, from the perineal branch of the pudic nerves, supply the under surface of the penis ; and from the same source also are derived muscular branches,

to the accelerator urinæ, and to the erector penis, as well as a branch to the transverse muscle of the perineum. The pudic nerve likewise gives off the nerve of the bulb, which is distributed to the corpus spongiosum, around the urethra. But the prostatic plexus of the sympathetic nerve, supplies an offset to the corpora cavernosa, some cavernous filaments also penetrating the corpus spongiosum; and these cavernous nerves communicate with the dorsal nerve of the pudic.

Female Urethra.—In the female, the urethral canal is shorter, wider, and straighter than in the male. Averaging in length only one inch and a half; its diameter is a quarter of an inch, or more, but enlarged and funnel-shaped adjoining the neck of the bladder, narrowed at the external orifice, with a dilatation in the floor of the urethra near the meatus. The course of this canal is nearly straight, having a slight curve below the symphysis pubis, the concavity looking upwards.

Lying in the middle line, the urethra passes from the bladder through the triangular ligament, in the pubic arch, to the external orifice; but, throughout its course, the tube is embedded in the texture of the upper or anterior wall of the vagina, the compressor urethræ muscle embraces it in the arch of the pubes, between the two layers of the triangular ligament, and behind this structure, the anterior ligament of the bladder overlays the vesical portion of the tube. Owing, however, to the comparative absence of unyielding structures around the urethral tube, it admits of dilatation much more readily than the male urethra. The external

orifice, or *meatus urinarius*, is a small, round opening, set in an elevation; it is situated within the vulva, immediately above the entrance to the vagina, and below the symphysis pubis, about an inch beneath and behind the clitoris, and between the commissure of the inner, smaller labia, or nymphæ.

The urethral tube consists of mucous membrane with an outer layer of sub-mucous cellular and elastic tissue, enveloped by a vascular structure containing a plexus of veins. The mucous membrane has a pale colour, except adjoining the external orifice; and it presents longitudinal folds, one more especially, in the floor of the canal, which corresponds to the median crest in the prostatic portion of the male urethra. Numerous tubular mucous glands lie between the folds of membrane, with their apertures directed towards the bladder; and mucous follicles open within, and around the outer orifice of the urethra. Both these forms of gland are of larger size towards the more external portion of the tube. The *vessels* and *nerves* proceed from those which supply *the vagina*.

CHAPTER I

FUNCTIONAL DISORDERS

I SCARCELY need observe that Pathology recognises two forms of disease—derangements of function and alterations of structure ; both forms of deviation being estimated by comparison with a presumed standard of health. Alterations of structure, including those of physical character and chemical composition, are together represented by Pathological Anatomy, while Pathology proper is thus restricted to disorders of function. Such then is the general nature of Pathology, and such its more limited and usual signification.

The two conditions of disease are frequently associated, if not inseparably united. But diseases of structure *precede* their functional manifestations. It may be that the earliest alterations of structure are minute, and therefore likely to escape detection ; or that such alterations relate only to the vascular condition of the tissue or organ affected, and that they are almost or altogether effaced previous to a post-mortem examination (should the disease prove fatal), and thus many nervous diseases may appear purely functional ; but instances of functional disturbance *alone* are very doubtful, and are gradually being reclaimed to altered

structure. Functional deviations from the standard of health have no significance apart from their preceding and accompanying alterations of structure; and common experience reminds us of many instances of sudden death, where chronic organic lesions have been discovered, the existence of which had never been even suspected by the patient, or the practitioner, during life.

Clinical investigation, therefore, may commence with some disorder of function,—of which perhaps the patient complains, and for which he seeks remedy or relief; but in our examination, we should always seek to connect that disorder with an allied alteration of structure in the organ or part affected,—as being the internal *cause* in operation. But the organ which was primarily the seat of structural change, may be *remote* from that which first attracted attention; and thus a mere local functional disturbance may prove to be a symptom of disease in operation at perchance some distance off in the body, and which, therefore, would not *appear* to be the cause of the topical disturbance—through the medium of the organ secondarily at fault. Hence the value of many *symptoms*, which although themselves comparatively insignificant, may yet guide us to the detection of latent disease in some distant, and hitherto unsuspected organ. Irritability of the urinary bladder, for instance—representing only a more or less painfully urgent desire to frequently discharge the contents of the bladder—is a functional disorder of this organ, which, arising often from some morbid condition of the urine, may prove to be the local symptom that first directs attention to this condition; itself due

to a far more grave disease of the kidneys, the stomach, the blood, or the nervous system.

By pursuing the investigation of internal causes, we may be led to discover some *constitutional* condition, as distinguished from any localised disease. If we seek to analyse the nature of constitutional causes, they may perhaps be reduced to the agency of the *blood* in circulation throughout the body, and to the general distribution of *nervous* influence from the central nervous system—cerebro-spinal and sympathetic—to every part. The *nervi-vasorum* accompany the blood-vessels in their distribution to every constituent organ, and nearly every component tissue of the body; regulating the quantity of blood supplied through the capillary vessels, if not somewhat affecting the quality of the vital fluid, in every part. These two agents—the blood and the nervous system—are together the bond of functional union and sympathy between distant parts; and thus may be explained the intimate relations which subsist between their diseased conditions.

Bearing in mind these general considerations respecting the connection of functional with structural conditions of disease, and also as to the investigation of internal causes, local and constitutional,—we are prepared to enter into the pathology, and thence the treatment of diseases pertaining to, or affecting, the urinary bladder.

This organ is subject to various functional disorders, which apparently may, or may not, depend on alterations of structure; or be referable perhaps to latent constitutional causes.

These disorders of *function* comprise:—(1) irritability of the bladder, with frequent and painfully urgent micturition; (2) spasmodic action; (3) neuralgia; (4) paralysis; (5) atony; (6) incontinence or involuntary escape of urine; (7) engorgement of the bladder, and overflow of urine; (8) retention of urine.

The anatomical structure of the bladder—as already described—has important relations to these different functional disorders of this organ.

IRRITABILITY OF THE BLADDER.—The healthy irritability of the urinary bladder is the vital property of the muscular bands, in its middle coat. Stimulated by the urine contained in the bladder, this middle layer contracts both vertically and transversely; and thus, aided by the voluntary action of the abdominal muscular parietes compressing the viscera downwards on the bladder, the contents of this organ are expelled, as occasion may require. In the intervals of micturition, the tonic contraction of this muscular or middle coat of the bladder maintains a certain compressive action on the contained urine, resisting over-distension of the organ. The pathological condition of increased irritability or contractility is immediately referable to the same *muscular* constituent of the bladder, and this morbid state induces *frequent* micturition; but the *painfully urgent* character of the desire to expel the urine, more frequently, is due to a similar exalted sensibility of one or other systems of *nerves*, or may be referable to both.

Irritability of the urinary bladder—thus a musculo-

nervous functional disorder of this organ—has a widespread etiology, comprising both local and constitutional causes; the latter relating to morbid states of the blood or of the nervous system, and connected often with various hygienic and social habits of life.

In tracing these causes, it should be remembered that the bladder has its nervous and vascular relation to surrounding organs, as well as to organs distant in the body. On the other hand, the organ itself may be the seat of irritation, in disease of the bladder; or its contents may be the source of direct irritation; as by the presence of morbid conditions of urine, blood, or stone in the bladder.

All the causative conditions of vesical irritability may be arranged under the following heads:—

Local causes.—(1) Habitual Constipation and Diseases of the Rectum; principally—hæmorrhoids, fissured anus, inflammation of the rectum, stricture of the bowel, cancer, abscess about the rectum, and fistula in ano; (2) Displacements and Diseases of the Uterus and Vagina; chiefly—prolapsus uteri, or vaginæ, metritis or inflammation of the uterus, cancer, fibrous or other tumour; (3) Stricture of the Urethra, organic, spasmodic, inflammatory, also phimosis; (4) Diseases of the Prostate Gland; chiefly—hypertrophy or chronic enlargement, prostatitis or inflammation, cancer, and other tumours; (5) Diseases of the Bladder, principally—cystitis or inflammation, acute and chronic, cancer, hæmaturia or blood in the urine, stone. Morbid conditions of the urine itself, rank as local causes of vesical irritability, by their direct operation on the interior of

the bladder ; but, as pertaining to Urinary Pathology, they are included under the second general heading.

Constitutional causes.—This great class of causes embraces (1) Morbid conditions of the Blood, (2) those of the Nervous System.

Morbid conditions of the *blood* result from perversions of the blood-forming processes ; (a) by mal-assimilation, primarily in the process of digestion, or secondarily in the process of nutrition ; (b) by mal-excretion, through the kidneys, the skin, or the liver. Diseases of the *organs*, severally concerned in these processes, give rise to the consequent blood conditions ; and they, in their turn, are manifested by corresponding states of the urine and urinary deposits ; the whole constituting Urinary Pathology. In relation to irritability of the urinary bladder ; the organic conditions are remote causes, the urinary conditions are direct or immediate causes ; while the blood-vascular system is the medium of communication. The chief of these urinary diseases are, lithic acid and lithates ; oxalates ; and phosphates.

Morbid conditions of the *nervous system* comprise diseases of the nervous centres—brain, and spinal cord ; and of the ganglionic centres of the sympathetic nervous system. Diseases of these central *organs*, and of organs generally, being severally connected through the medium of nervous influence, they may thence become causes of irritability of the urinary bladder. Whatever may be the essential pathology of hysteria, no disease manifested through the nervous system, is more often attended with vesical irritability.

It thus appears that diseases of organs *distant* in the

body, from the urinary bladder, are brought to bear upon this organ, through the agency of the vascular and nervous systems; just as *local* diseases generally operate, in like manner, upon this organ.

Hence the wide-spread etiology of irritability of the bladder. This affection is, therefore, not merely a symptom which may be selected for the convenience of associating much valuable clinical experience pertaining to diseases, different in themselves. As a symptom it may also have a very important *etiological* significance, by leading to the discovery of latent disease, in perchance some distant and previously unsuspected organ or part of the body; while the continued influence of such disease, and thence its *prognosis*, may perhaps be determined by the persistence of the vesical irritability.

Treatment.—Remedial measures must have reference to the removal of any cause or causes, local or constitutional. The treatment of *local* causes relates to the various diseases of the bladder and adjacent organs, already enumerated. Excluding diseases of the rectum, and those of the uterus and vagina, the diseases of the bladder, prostate gland, and urethra will be fully noticed in the course of this treatise. *Constitutional* causes also, both from a remedial and preventive point of view, are fully considered with urinary diseases.

But in the treatment of vesical irritability, the *hygienic* origin of constitutional disease, conjoined with social habits, should always form the subject of special inquiry. Thus, the mal-assimilation of food in the process of digestion, is often referable to *errors of diet*; followed perhaps also by rectal constipation. The

correction of any such dietetic error, by proper injunctions to the patient, must not be overlooked, or medicinal agents will be prescribed in vain. The practitioner may have to deal with dyspepsia or indigestion in its various manifestations; the distinctive symptoms of which seem due to the nerves, blood-vessels, and muscular fibres of the stomach. Thus we recognise irritable dyspepsia, associated with pain after food, nausea, or actual sickness, and acidity; the inflammatory variety, known by the same gastric symptoms; coupled, however, with general febrile disturbance; while atonic dyspepsia is distinguished by abdominal distension, flatus-eructations, lethargy, and general debility. We may not always succeed in connecting this or that form of indigestion with this or that error of diet; but the atonic variety is often associated with excess of vegetable food; while irritable and inflammatory indigestion, followed by a gouty tendency, lithic acid or lithates in the urine, and irritability of the bladder, proceed frequently from an undue proportion of the more stimulating species of animal food. Nor are the artificial resources of the *cuisine* wanting to perplex the stomach, in all the treacherous forms of "made-dishes;" ignoring the great object of cookery, —to prepare food for digestion, or solution in the stomach, as well as to make it palatable.

Among diseases of, or affecting the nervous system, *hysteria* is commonly engendered by a vicious social training in youth, and by a similar existence in after-years. "You can render"—observes Sir B. Brodie—"no more essential service to the affluent classes of

society than by availing yourselves of every opportunity of explaining to parents how much the ordinary system of education tends to engender the disposition to 'nervous affections' among their female children. The boys are sent at an early age to school, where a large portion of their time is passed in taking exercise in the open air; while their sisters are confined to heated rooms, taking little exercise out of doors, and often none at all, except in a carriage. Then, for the most part, the latter spend much more time in actual study than the former. The mind is over-educated at the expense of the body, and, after all, with little advantage to the mind itself; for who can doubt that the principal object of this part of education should be, not so much to fill the mind with knowledge, as to *train* it to a right exercise of its intellectual and moral faculties, or that, other things being the same, this is more easily accomplished in those whose animal functions are preserved in a healthy state, than it is in others?" Again, it may be that the social condition of an individual, exempts him or her from the necessity of any daily occupation. The intellectual faculties, not being roused by the stimulus of any professional avocation or the pursuit of trade, are prone to inactivity. Under such circumstances, the emotions are apt to be lively. Hence the origin, or at least one source, of that peculiar morbid susceptibility, the sensitiveness of those who are "all feeling;" hence that restless apprehension of some impending evil, the very offspring of luxury and ease; hence, sometimes perchance, that suicidal melancholy, "which rejoiceth exceedingly and

is glad when it can find the grave." If, however, through intellectual lethargy, an emotional character be developed, such a person often becomes the victim of painful sensibility—bodily, as well as mental. An original observer* truly remarks—"such persons are commonly called nervous. They are worried with trifles, startled at shadows, distracted by noise or bustle, never free from some ache or pain, almost every feeling is suffering; what in others would be slight pain, in them amounts to agony. Hence they are perpetual invalids, quite unfit for the rugged path of life, over which they walk, as it were, barefooted and thinskinned."

Among persons, more commonly such as these, in youth, and after-life, may be noticed the victims of *local* nervous affections: they are subject to that piercing kind of headache known as *clavus hystericus*; spinal and abdominal tenderness; pains in the breasts and joints. With pains, and penalties, thus flying about the body, as local manifestations of an undue general sensibility, various perversions of the special senses are perhaps associated. The taste may prefer wormwood to honey, and chalk rather than cheese, the eye may be intolerant of light, every smell may be a stench, and every sound a discord. To these depraved sensations may be added certain functional derangements of the internal organs, proceeding from excitement of either the great sympathetic or spinal nervous systems. Thence, palpitation of the heart and breathless agitation, with a distressing sensation of choking, from the rising, as it were, of a ball in the throat; attacks of hoarseness or loss of voice, of

* 'Principles of Medicine.' C. J. B. Williams.

hiccough or dry loud coughing, of vomiting, or diarrhoea ; and the frequent occurrence of an irritability of the bladder, which is accompanied with the abundant discharge of a pale, limpid, watery urine. Lastly, these phrases of nervous excitement occasionally terminate in a sudden and violent paroxysm, or *fit*, of involuntary, or at least perhaps uncontrollable movements ; although consciousness is retained,—unlike an epileptic seizure, even when unattended with convulsions, but occurring only as a sudden and brief loss of consciousness.

Such then is the social origin and general character of the ordinary functional disturbances of the nervous system, which taken collectively, have received the inappropriate name of Hysteria—a word which, from its etymological meaning, would imply some disease of the uterus, but which in reality is not peculiar to the female sex ; being occasionally witnessed in males, as the experience of every medical observer, and indeed common experience, will testify. The frequent occurrence of uterine disorder, in connection with hysteria, is consistent with the nervous endowments of the organ affected ; by virtue of which, it—the uterus—is so intimately related to the entire nervous system, as to respond most promptly to its prevailing condition, whatever that may be. But the nervous excitement of hysteria does not emanate from the uterus ; for in most cases the function of menstruation is not impaired in the first instance ; while sometimes that function continues to be fulfilled regularly and sufficiently, and seldom the organ itself presents any organic disease or displacement.

The *treatment* of hysteria—as a constitutional disease, and having regard to its social origin—will assuredly *not* consist in the administration of uterine remedies; nor in the rash, repeated, and demoralising introduction of a vaginal speculum, to inspect what?—“a prominent spot of varying size;” “a something raised;” “an abrasion or erosion.” The judicious practitioner will begin by searching out those causes—physical, mental, or moral—which have produced the hysteric diathesis. Its evil origin lies often in the depths of a vicious education; an indoor life, with high pressure schooling for accomplishments; while in after-years, the hysteric patient is often the victim of that *ennui* and mental fallowness, or moral perversion, which proceeds from the want of a daily occupation of the head and heart with something better than mere passing circumstances, the pursuit of some object in life, worthy of a rational and responsible being. No medicinal treatment can avail under any such adverse circumstances; but when they are corrected, then the known resources of medicine may do much to relieve, if not to cure the *symptoms* of hysteria. The nervous excitement is frequently accompanied with general debility, and muscular irritability, especially of the urinary bladder. Tonics and antispasmodics may, therefore, be prescribed with advantage. And in these two classes of medicine, none are so efficacious as cinchona or cascarilla bark, and sulphuric ether or the ethereal compounds. In the case of a young married woman, under my care, an uncontrollable desire to micturate occurred every few minutes; yet this vesical irritability

subsided under these remedial measures, and she contained her urine for the full average period. At the same time, one should not overlook the benefit to be derived sometimes from preparations of valerian and assafoetida; the nitrate of silver, or the sulphate of zinc; or the preparations of iron or copper. The careful regulation of the diet is of paramount importance; for the appetite, although sometimes voracious, is rarely selective of digestible food; and the digestive process itself is often imperfect, resulting in mal-assimilation, and constipation alternating with fitful diarrhoea, lumpy faeces passing from the cells of the colon or which were impacted in the rectum. In such cases, the attacks of vesical irritability are generally most distressing. Here the action of assafoetida proves specially beneficial; or, a dinner-pill of gentian and aloes will prevent or remove the oft-recurring source of intestinal irritation. Rectal constipation is perhaps best relieved by the simple *lavement* of cold water, or an enema of soap-suds and castor oil, as occasion may require.

Lastly, as a topical sedative to irritability of the bladder, from whatever cause, I have used suppositories, with satisfactory reports in their favour; the usual form having been *Pil. Saponis Co.* introduced into the bowel at night, when sleep would otherwise be disturbed by the frequency of micturition.

Two other affections of the bladder, akin to irritability of this organ, are occasionally met with.

Spasm of the bladder is said to be an involuntary, uncontrollable, and exceedingly painful contraction,

occurring from time to time ; the cause being various, —inflammation, stone, a morbid growth or tumour. Spasm, like irritability, is therefore a symptom only, of which disease is the cause. I am disposed to regard both these symptoms as the same, differing in their degree of intensity ; spasm representing excessive irritability of the bladder, with an acutely painful urgency of micturition. The *treatment* is that of cystitis ; or the removal of any foreign body from the bladder, where practicable ; as a calculus, by the operation of lithotomy rather than by lithotrity.

Neuralgia, or an excessive sensibility of the neck of the bladder, with perhaps paroxysms of acute pain, may occur ; unaccompanied with any apparent organic disease. A correct diagnosis is very important ; lest perchance stone in the bladder, or some disease be mistaken for neuralgia ; or the worse error be committed, of attributing a neuralgic condition to some such organic cause, which would sadly mislead the treatment. This painful affection seems to arise more often from some constitutional cause, resulting in a generally depressed state of the nervous system and of the circulation ; especially, from the blood-condition of chronic rheumatism, or the anæmia of malarious poisoning ; thus illustrating the truth of Romberg's graphic expression, —that “neuralgia is the prayer of the nerve for healthy blood.” But vesical neuralgia may also proceed from rectal constipation, the constant excitement induced by sexual excesses, habitual masturbation, or other local causes of nervous irritation. *Treatment* consists in the removal of any causative condition, and the administra-

tion of anodynes or the use of suppositories, with tonics ; a well-regulated diet and state of the bowels, change of air, and other hygienic resources. One of the worst cases I ever had to manage was in an old, enfeebled debauchee, and whose rectum was often loaded with the feculent matter of hard, undigested food. He became much relieved under this plan of treatment, and especially by attention to the rectal constipation.

PARALYSIS OF THE BLADDER.—This functional state of the bladder signifies a loss or impairment of the contractile power of its muscular fibres, by failure of the nervous influence to this organ. The causes of vesical palsy are of two kinds. It usually depends on some lesion of the brain or spinal cord. Thus, it may occur in connection with injury to the head or spine ; or from disease, as apoplexy, softening, or other structurally destructive disease of the nerve-centres. But the paralysis may depend on functional conditions : as in hysteria, spinal debility from sexual excesses ; reflex action from some source of irritation, as hæmorrhoids and after operations for their removal ; the shock of injury, the result of fever ; and the influence of certain medicinal agents, as belladonna, hyoscyamus. The prognosis of vesical paralysis, as arising from these two classes of causes, differs considerably. Functional disturbances of the nervous system, for example, have only a temporary effect, the bladder regaining its expulsive power ; whereas structural lesions of the nerve-centres, are not only of a persistent character, but they involve other parts, besides paralysing the bladder. Paralysis of the bladder alone, with retention of urine,

or of its neck only, with incontinence, is extremely rare; such cases of apparent paralysis are usually states of atony, resulting from over-distension.

The retention of urine, and a distended state of the bladder, can be readily ascertained by percussion above the pubes; the bag of fluid emitting a dull sound when percussed in the usual manner, and the area of dulness may gradually extend up to the umbilicus, as the bladder becomes yet more distended with urine.

Treatment.—Whatever may be the cause of vesical paralysis, the retention of urine will constantly engage the surgeon's attention. The urine must be drawn off, and the bladder emptied two or three times a day by means of a full-sized catheter. This instrument should be used gently, even when an elastic catheter is introduced, the bladder having lost its sensibility to pain when injury is inflicted, and the urethra being often in a lax state. The stream of urine will be small or perhaps dribbling, for the bladder has lost also its contractile power; the propulsive action now depending on the compression produced by the abdominal muscles alone, when not involved in the vesical paralysis. Chronic cystitis is apt to supervene; a low inflammation of the mucous membrane of the bladder, partly as the result of frequent distension of the organ, but principally consequent on the deprivation of nervous influence. This inflammatory state should be treated chiefly by local measures; injections of tepid water to wash out the foetid, ammoniacal, muco-purulent matter from the bladder; followed by weak astringent injections, as the dilute nitric acid, say ten or fifteen minims to the

ounce of water, which may be allowed to remain in the bladder for a minute or two. These injections should be regulated by two considerations; the decomposed state of the purulent matter tends to maintain the cystitis; and the greater tendency of the mucous membrane to ulceration from paralysis of the bladder, rather than in ordinary chronic cystitis. Of course, a non-metallic instrument must be used for an acid injection. Curative treatment will have for its object, the restoration of innervation—the supply of nervous influence to the bladder. But remembering the nature of certain causes of vesical paralysis, it may be hardly possible to hope for a successful result; as in fracture of the spine. In chronic cases—when not depending on any persistent cause—strychnia, iron, arsenic, cantharides, and ergot of rye, may prove beneficial; while, of local measures, blistering, cold douches, and electricity are the most promising.

ATONY, FROM OVER-DISTENSION.—Unlike paralysis of the bladder, which proceeds from the failure of its contractile power, giving rise to retention of urine, atony of the bladder arises from retention, amounting to distension, which overcomes the contractile power of this organ. Over-distension is the result of some organic obstruction, usually stricture or enlarged prostate, impeding the evacuation of urine. The resistance thus offered to the passage of urine, or by its accumulation, is greater than the expelling force. After each act of micturition, therefore, the bladder is incompletely emptied. The residual urine maintains some degree of distension, relieved from time to time by strong

expulsive efforts, or by relaxation of the sphincter during sleep. But the bladder gradually becomes over-stretched, and losing its contractility, remains in an atonic state and enlarged. Chronic cystitis often supervenes.

The *treatment* of vesical atony must have regard to the removal of any cause of obstruction to the free passage of urine, and the prevention of any retention ; so that the bladder may recover its normal tone. The urine should be regularly drawn off once or twice daily ; and only a small slow stream will be procured, owing to the atonic state of the bladder. But as the organ regains its power, injections of cold water may be used with advantage ; and medical treatment, of a stimulant and tonic character, as in paralysis, may also have a beneficial effect.

Engorgement of the bladder and overflow of urine, is a condition allied to atony from over-distension. Engorgement arises from enlargement of the prostate, which rising up at the neck of the bladder, forms a receptacle in the fundus, wherein urine accumulates. The urine rising above the level of the prostate, distends the bladder to engorgement, when a portion of the fluid escapes as an overflow, and the distension may be relieved down to the level of the prostate. But there is still partial retention, and instead of the occasional overflow, the bladder may remain engorged ; and then over-distension at length results in atony of the bladder, with complete retention. This result is not unfrequently induced by a 'prostatic attack ;' exposure to cold, or an irritant state of the urine, may provoke

the prostate to further enlargement than usual, and cause retention sufficiently to require the aid of catheterism for relief; but when this attack subsides, and the instrument passes readily, the bladder has relaxed into an atonic condition, so that the patient himself cannot pass water. Such was the case in a somewhat elderly surgeon whom I attended, and whose bladder never regained its tone.

The *treatment* by catheterism, peculiar to enlarged prostate, will be described hereafter.

INCONTINENCE OF URINE.—Hitherto I have described those functional disorders of the bladder, which are manifested by frequent micturition, whether from vesical irritability, spasm, or neuralgia; or, again, in which the central symptom is retention of urine more or less completely, whether from vesical paralysis, atony, or engorgement with overflow. I have yet to notice incontinence, or an involuntary escape of urine; a symptom of one or other of two opposite conditions: in one, the bladder does not retain its contents, in the other the bladder is full, almost to repletion.

An involuntary escape of urine differs from frequent micturition, which is of a voluntary, although painfully urgent character. But incontinence of urine is not necessarily symptomatic of deficient voluntary power of retention. In *childhood*, when this power is temporarily suspended during sleep, the sphincter of the bladder may be relaxed, and then the urine runs off until the bladder is empty; in *adult* life, an over-distended bladder may relieve itself, a certain quantity of the

urine running off, but leaving a quantity still retained, and this incontinence may happen during sleeping or waking. An involuntary escape of urine in the adult, always indicates a distended, not an empty state of the bladder, after it has occurred. The neck of the bladder may be the seat of *structural* disease, or malformation; occasionally, of disorganization resulting from injury, as from a kick or fall on the perineum, or the operation of lithotomy. In such cases there is no power of retention; the unhappy sufferer has lost, or may never have possessed, command over his bladder, and the sphincter is itself powerless to contract. Then the incontinence is usually a *continual* dribbling, the urine running off from the bladder as fast as it arrives there from the kidneys. This condition, therefore, differs from both the ordinary modes of incontinence, in childhood or adult life. It differs also from frequent micturition; not only in its involuntary character, but in there being no distinct acts of micturition.

The *causes* of incontinence differ according to the period of life at which it occurs, in relation to the state of the bladder. A *child* wets his bed, owing to relaxation of the sphincter, from various causes; general debility, and an apparently hysterical diathesis, or from intestinal irritation, sometimes in consequence of habitual masturbation, or an acid state of the urine. An *adult* is liable to incontinence from the causes of retention; paralysis affecting the bladder, atony from over-distension, stricture, enlargement of the prostate, cystitis, stone. In the *female*, hysterical incontinence is not unfrequently met with; but an involuntary drib-

bling is generally the result of some injury to the urethra, impairing or destroying the action of the sphincter; such as sloughing from pressure in difficult labour, or the bruising effect of instruments in delivery; or from over-dilatation of the urethra for the extraction of stone in the bladder.

Treatment.—In *children*, a general tonic plan of treatment is commonly indicated, combined sometimes with sedatives. Thus, the vinum ferri, or the sesquichloride of iron, quinine, strychnia, tincture of cantharides, may severally prove beneficial. Sir H. Thompson speaks highly of the extract of belladonna, commencing, according to the age of the patient, with the sixteenth to the eighth of a grain twice a day. In extremely obstinate cases, he recommends a solution of nitrate of silver, ten grains to the ounce, as an injection to the prostatic portion of the urethra and neck of the bladder. In the female, this remedy is easily applied. The sacro-lumbar region may be subjected to the influence of a cold douche every morning; or to counter-irritation, occasionally, by blistering. Any source of irritation must be removed, as intestinal worms; masturbation, when practised, should be prevented, if possible; and acidity of the urine corrected. Under this course of treatment the child, who previously had piddled his bed perhaps every night, may at length retain his water; care being taken not to allow the whole night to pass without seeing that the little patient's bladder is voluntarily relieved. After puberty, the child will generally outgrow the complaint. This happy result was obtained in the case of a young

gentleman, about whose incontinence I was consulted by the late Mr. J. F. Clarke; the anxious parents fearing that his vesical weakness might portend some generative incapacity. The most troublesome case to deal with, is that of an imbecile or daft child; in whom, I may remark, although the bladder is often incontinent, the genitals may be prematurely developed.

In *adults*, the distended bladder must be relieved by passing a catheter, as occasion requires; and remedial measures should be directed to overcome the causes of incontinence. In cases of an incurable character, a urinal may be worn with great comfort. Various contrivances have been used; one of the best being a vulcanized india-rubber bag, on the inner side of the thigh, attached by a tube to the penis, and provided with a distal tube passing down the leg to the heel of the boot, where, by means of a small concealed stopcock, the urine can be let off. A patient told me that, wearing this contrivance, he could readily relieve himself over a drainage-grating in a public thoroughfare unperceived by any one, and, therefore, without offence to public decency. The street-urinals of this metropolis are too few and far between for ordinary convenience; and certainly they offer inadequate provision for the more urgent necessities of all those—a very numerous class—who suffer from some affection of the bladder. But perhaps the Board of Works have no such visitings of nature; and vestries are quite above them.

CHAPTER II

DISEASES OF THE BLADDER

IN pursuing the order of clinical investigation, we pass from functional disorders to diseases of the bladder—from symptoms to their causes, so far as structural alterations of the organ affected have that relationship—a natural and easy transition, and which has been already anticipated in the course of the previous chapter.

The diseases to which the bladder is subject, are not different in their nature from those of other organs, but they present special and important modifications in their pathology and symptoms, and thence in their treatment. Thus, inflammation, known as cystitis, acute and chronic, and various morbid growths or tumours, may affect the bladder; and the malformations of this organ are peculiar; while the injuries to which it is liable are worthy of some special notice.

CYSTITIS.—*Acute* inflammation of the bladder is, in my experience, less frequently met with than the chronic form of this disease; but as being often the primary affection, it first merits attention. The patient complains of severe pain and a sense of aching weight in

the region of the bladder above the pubes, extending into the urethra and perineum, and even down the thighs; this pain is accompanied by frequent and very urgent micturition,—the urine being expelled at short intervals, in small quantities, and by spasmodic straining efforts to drain off the last drop. Let any one witness, not to say experience, a paroxysm of this kind, and he will not soon forget it.

These symptoms are those of the irritable bladder, only in an extreme degree. But on placing the hand just above the pubes, the contracted bladder, forming a small, round, and firm tumour, will be found exceeding painful on pressure, or when touched or tilted with the finger through the rectum, or vagina; while, the character of the urine also, which is high-coloured and acid, mixed with milky mucus or purulent matter, and perhaps tinged with blood, proclaims an inflamed state of the vesical mucous membrane. When this urine has stood for a few hours in a receptacle, it deposits a whitish, semi-transparent cloud,—somewhat opaque and yellowish, when purulent; or of a brownish tint, when blood-stained. On dipping a spill of paper into this cloudy deposit, it is found to be more or less viscid and tenacious, as the mucous or purulent matter prevails. Sometimes, the urine is alkaline, and drops a small quantity of brownish adhesive mucus, which clings with more tenacity to the bottom of the vessel.

The constitutional disturbance or inflammatory fever is often severe.

Various causes may give rise to acute cystitis. Commonly, it is the consequence of inflammation ex-

tending from some neighbouring part; retrocedent gonorrhœa, invading the neck of the bladder; or an extension of inflammation from the prostate, rectum, or kidneys. Injuries also may have a similar influence; such as a kick on the perineum or pelvic fracture; but more frequent causes are, operations of lithotrity, rough or prolonged catheterism, injections, or lithotomy; in the female, tedious, or instrumental labours; also the mechanical irritation of a stone in the bladder, the action of the urine itself, retained and decomposed, as in stricture or prostatic enlargement; the stimulant effect of cantharides, or of some mineral poisons, and strong diuretics. Sometimes, exposure to cold has touched the bladder, as, I have known to occur, from sitting on damp grass at a picnic; and sometimes the disease is a touch of the gout. Any person subject to the chronic form of cystitis is liable to an acute attack.

Cystitis usually commences suddenly, and runs a rapid course; terminating, usually, in resolution,—the symptoms passing off; and even in the stage of purulent secretion, recovery is not uncommon; or the disease may subside into the chronic form; but a fatal issue may occur from suppuration in the wall of the bladder, leading to peritonitis, or between the bladder and rectum, followed by urinary infiltration and pelvic cellulitis, ulceration or sloughing of the mucous membrane taking place in the worst cases.

Treatment.—To subdue acute inflammation of the bladder, the plan of treatment will generally consist in derivation, and the administration of alkalies and diluents, to render the urine unirritating, with the influence

of opium, to allay pain and spasm. By perfect rest in the recumbent position, the bladder is relieved of the whole weight of the upward column of blood; and this derivation may be aided by warm fomentations to the abdomen, and leeches to the perineum. The bowels should be kept comfortably open by laxative aperients, which in having a derivative action, remove also any intestinal irritation. A dose of calomel in the beginning, may be followed by castor oil or salines; a bedpan being used, so that the patient shall not rise up, and perhaps also take a chill, whenever the bowels are relieved. Diluent drinks, such as barley-water, should be liberally allowed; and the citrate or nitrate of potash, largely diluted; taking care, however, not to trouble the bladder by aggravating the frequent micturition. The distressing vesical irritability is, I think, best subdued by opium, in the form of enema or suppository; while the continued influence of opiates, taken internally, tends to allay pain and overcome inflammation. Belladonna, hyoscyamus, and conium have also some reputed efficacy, whether administered by the mouth or per rectum.

If cystitis be the consequence of *retrocedent* gonorrhoea, the return of urethral discharge should be solicited by warm fomentations to the penis, or by wrapping it in a poultice. Conditions of the *urine* must also be attended to, as special causes of cystitis. When the urine is acid, with a yellowish and diffuent—or purulent sediment, calomel and opium—two grains to half a grain, in pill, may be taken twice or three times a day; as originally recommended by Sir B. Brodie.

When, as he observes, the urine is alkaline, with the brownish adhesive mucus deposit, colchicum should be given, say fifteen-minim doses of the wine, thrice daily, for three or four days. Cystitis resulting from *cantharides*, comes on usually within two or three hours after the dose, or absorption from a blister; although attended with pain in the loins, and bloody urine, the symptoms soon subside, perhaps in from six to twelve hours. Bicarbonate of potash and full doses of hyoscyamus may be given every half hour for three or four hours; and the patient should lie down—as, indeed, he will be sure to do, until the renal and vesical irritation have passed off. If a blister be the cause, it must be removed at once, and the surface thoroughly sponged free of every particle of cantharides.

Chronic cystitis.—This form of the disease is always attended with muco-purulent matter in the urine; and the mucous membrane of the bladder has become thickened, velvety, and of a dark colour; the vessels being much congested, and the muscular coat somewhat hypertrophied. This condition is most marked, when the secretion has been abundant, as *catarrh* of the bladder or cystorrhœa.

The same symptoms are presented as in acute cystitis, modified only by the chronic character of the inflammation. The latter is distinguished by the discharge of thick, tenacious, greyish-white, muco-purulent matter, in greater or less abundance, and which gradually falls to the bottom of the vessel in which the urine is collected. This deposit appears as a semi-transparent jelly, something like parboiled white of egg; and on pouring off the urine, it hangs slightly adherent to the

vessel, and then slides down suddenly in a lump, or it can be poured out in long tenacious coils, resembling macaroni. This mucous mass may be tinged with blood, and often presents white streaks of phosphate of lime. The urine itself is brownish, ammoniacal, and foetid; or it soon decomposes. In this advanced state of the disease, the constitutional symptoms are those of a typhoid febrile condition; fits of shivering mark the accession of pyæmic infection, the pulse becoming extremely rapid and feeble, the tongue dry and brown, with great prostration and cerebral oppression; or, the suppression of urinary excretion denotes the stealthy supervention of uræmic blood-poisoning, attended with similar symptoms, and low muttering; but, in either case, the end is near at hand. Sometimes, however, neither the pyæmic shudder, nor uræmic wandering, is ominous of the fatal issue. The patient sinks almost suddenly, as if from the shock of injury. Yet one more attack of his old complaint, and the nervous system, shattered by years of suffering, responds no longer to pain; a brief period of serene and deceptive calm might mislead the inexperienced friend or relative to a hope of recovery; but soon the drawn and collapsed features of the worn-down form dispel this illusion; some flickering up of consciousness may afford time for parting recognition, ere the soul seems to catch the first glimpse of that unseen world which lies beyond the horizon of this world of sense.

In tracing the history of cystitis, the chronic form of the disease is often found to be a lingering sequence of acute inflammation of the bladder. But persistent

inflammation may also have an independent origin, from any cause of long-continued vesical irritation :— from a calculus, or other foreign body, or any species of tumour in the bladder ; or from the retention and decomposition of urine ; as in stricture of the urethra, or enlargement of the prostate, or in spinal paralysis. The latter disease is not only a cause of retention, but an inflammatory state of the vesical mucous membrane supervenes, as the result of impaired nervous influence.

Treatment.—As in acute cystitis, the indications of treatment comprise ; derivation from the bladder, correction of an irritant state of the urine, and the relief of vesical irritability and pain. For the purpose of counter-irritation,—not often, in my opinion, of much use—a mustard poultice or iodine paint may be applied, occasionally, to the supra-pubic region ; or a blistering liquid of cantharidine in chloroform to the perineum, when the neck of the bladder, more particularly, is affected. But measures should be more especially directed to arrest the abundant muco-purulent discharge, and to correct the alkaline state of the urine. Pareira brava, uva ursi, and buchu, given with the mineral acids, are more or less efficacious ; but I much prefer a concentrated decoction of pareira, with diluted nitro-muriatic acid, in ten or fifteen minim doses, taken three or four times daily. I have found gallic acid, in pill, useful in diminishing the secretion of ropy mucus ; and benzoic acid renders alkaline urine acid. Injections are safe, and highly serviceable, when no acute symptoms are present. They may be sedative—to quiet the bladder, as tepid water ; or decoction of

poppies, in quantities of not more than two ounces, and retained for half a minute once a day; or astringent injections, as diluted nitric acid, in the proportion of ten minims, gradually increased to twenty, in two ounces of water. These formulæ were first sanctioned by the experience of Sir B. Brodie. But others may be employed, if not preferably, at least when the former have failed or lost their effect. Thus, Sir H. Thompson advocates the acetate of lead, beginning with one sixth of a grain to the ounce of water; and next to this, the nitrate of silver, a grain to eight ounces of distilled water, and gradually carried up to one grain in the ounce of diluent. Carbolic acid, in a very weak solution, two or three grains to half a pint of water, is said to have a corrective effect on the urine, when foetid. But I am in the habit of simply washing out the bladder with water at blood temperature—98° to 100° Fahr. This can be done most effectually, by means of the bladder-injecting syringe, and large double-current catheter. The injection had better be limited to three or four ounces, thrown in with only just sufficient pressure to bathe the interior of the sensitive and irritable bladder. By these measures, coupled with tonics and a generous diet, to support the patient through the dread exhaustion of chronic cystitis, we may succeed in overcoming the progress of the disease. This, of course, implies the removal, when possible, of any causative condition. Hence, the treatment for stone in the bladder, or a tumour of this organ; and of the various causes of retention, such as stricture, enlarged prostate, paralysis.

TUMOURS OR MORBID GROWTHS OF THE BLADDER.—Various species of morbid growths may originate in the walls of the bladder, and project into its cavity, as a distinct tumour, having different forms; presenting either a warty excrescence, a pedunculated or polypoid form, or a broad-based mass, which occupies more or less the whole cavity of the bladder. But the detection of the presence of a tumour, is more important, practically, than the diagnosis of the species. When, therefore, a patient complains of vesical irritability, of perhaps long duration, and of an almost unremitting, and extremely urgent, character; when also constant pain, and muco-purulent discharge in the urine, would indicate the supervention of cystitis; these *mixed* symptoms would beget the suspicion of some source of irritation within the bladder, possibly a morbid growth; but if in addition, there have been occasional attacks of retention, partial or complete, and of *hæmaturia* or blood in the urine, to the amount of hæmorrhage; then the nature of the case becomes more evident, and the surgeon proceeds to examine the interior of the bladder with a sound. If, on sounding, he touches a tumour, and such examination provokes a return of hæmorrhage, on withdrawing the instrument, he may be nearly certain that he has found out a vesical morbid growth. But why not absolutely certain as to his judgment? Because the supposed tumour may be a calculus in the bladder. Now, under the touch or stroke of the sound, a morbid growth-tumour is soft and dull,—emitting no perceptible sound; a stone is hard, and answers with a click or perhaps ringing sound; and upon these points

of distinction, mainly turns the diagnosis. Sometimes, both tumour and stone coexist in the same bladder; then, the contrasted characters of the two bodies may be well declared; or the tumour may, at times, conceal or mask the stone. But there is yet possibly an exception to the ground of distinction otherwise; a tumour encrusted with calculous deposit may be met with. Then, indeed, the diagnosis is always difficult, and may be impossible. So here I leave the question for the moment.

Proceeding to consider the various *species* of morbid growths to which the bladder is liable, they may all be comprised under three descriptions:

Fibrous growth springs from the mucous membrane and submucous tissue, and consists of their elemental structures. Commencing in the form of a circumscribed elevation of the mucous membrane, it resembles a *warty* excrescence, but afterwards enlarges, and projects into a *polypoid* form.

The symptoms are those arising from any cause of vesical irritation, with obstruction perhaps to the free passage of urine; and there is also the presence of a foreign body in the bladder. Simulating stone, careful sounding may show, that the situation of this body is not the usual locality of a calculus,—in the fundus of the bladder, and the form of the tumour may be peculiar; besides which considerations, the general characters of difference—already mentioned—with reference to the density and sound of a stone, when struck, will determine the diagnosis.

Even an *encrusted* growth may be distinguished by

its fixed position, and the impossibility of passing a sound around the tumour, free of the bladder. Yet it must be confessed that the resemblance to an *encysted* calculus is then sufficiently perplexing to perhaps baffle the most careful exploration.

This species of vesical excrescence or polypus occurs mostly in childhood and youth. The absence of hæmaturia, or less free hæmorrhage, distinguishes fibrous growth from both the remaining species,—villous growth and cancer.

The *treatment* may always be of a palliative character; to mitigate pain and irritability of the bladder by means of opiates or other sedatives, and the use of suppositories; with occasional catheterism for the relief of retention. But the removal of a vesical polypus can seldom be accomplished with safety, and rarely with success. Civiale succeeded with a lithotrite; and Warner with a ligature—after dilating the urethra, in a female, the tumour being the size of an egg. Of fifteen cases, however, collected by Dr. Senftleben, in all, the patients died, save one. He therefore suggests supra-pubic cystotomy.

Villous or *vascular* growth springs also from the mucous and submucous tissues; but the cellular structure of this species abounds with large looped capillaries. It presents in the form of innumerable fine villous processes or tufts, branching up from the base in every direction. When floated in water, this growth appears as a soft, flocculent body, about the size of a large marble, or smaller, according to the state of development. Several such little tumours may coexist,

giving to the interior of the bladder a studded villous appearance.

No peculiar symptoms characterise this species of growth ; either with regard to obstruction, or the presence of a soft foreign body in the bladder. But the pain and vesical irritability are aggravated to the highest degree of intensity ; and the hæmorrhage is so copious and oft-recurring, that the *bloody* urine bespeaks the greater probability of our having to deal with a vascular growth. Shreds of the tumour sometimes come away in the urine, and, under the microscope, may bear direct structural evidence not to be mistaken.

Palliative measures only are available. The constant hæmorrhage may perhaps be restrained or controlled by astringents ; injections of acetate of lead or nitrate of silver, in weak solutions ; while gallic acid taken internally may somewhat check the tendency to bleeding. At the same time, the patient's strength must be supported by such tonics as iron and quinine, with nourishing food ; thus to overcome the exhaustion consequent on long-continued suffering, vesical irritability, and draining loss of blood. The villous state of the bladder forbids the introduction of any kind of instrument ; sounding will scarcely detect the presence of a growth so soft and flocculent ; catheterism aggravates the pain and irritation, and is very apt to provoke an attack of hæmorrhage ; while the extraction of a villous tuft would be equally perilous and unsuccessful. But with every care and attention by the surgeon, in doing what may be done, and avoiding improper treat-

ment; the blanched, bloodless appearance, and wasted form of the sufferer, at length tells too plainly of the almost inevitable issue.

Cancer of the bladder has a deeper clinical history than either of the other species of growths. It may originate in the walls of the bladder; or extend from the prostate, the rectum, or the uterus, as a form of secondary cancer. The species is generally encephaloid when the bladder is the seat of origin, and always of this kind when an outgrowth from the prostate; but as an extension from the rectum or uterus, scirrhus may be met with in the bladder, or epithelial cancer has a uterine origin. Colloid is of rare occurrence; yet, in a remarkable case, I found, after death, the whole cavity of the bladder blocked up with a semi-transparent, greenish-yellow, trembling mass of jelly; as if the organ were fully distended with urine by complete retention. Similar colloid deposits had taken place in the rectum and uterus, and in most of the abdominal viscera.*

The symptoms of cancer of the bladder are not peculiar; and yet taken singly and collectively, their character can scarcely fail to be misinterpreted. The pain, at first endurable, and referred to the loins and hips, or lower part of the belly, extending into the perineum and thighs, increases in severity, as a dull, aching pain, but is rarely lancinating. Vesical irritability is so urgent, that the urine is ejected every few minutes, and as ulceration of the bladder ensues, is expelled with

* 'Principles of Surgery.' By the Author. Introductory Elements of Pathological Anatomy. P. 55.

sweating agony. The semen also may be emitted, and the contents of the bowels evacuated, or a prolapsed eversion of the mucous membrane of the anus occur, during this strain of the last few drops of urine. Profuse and gushing hæmorrhage often accompanies or follows the act of micturition; or the urine may be bloody, alkaline, purulent, and foetid. All these suspicious symptoms are corroborated on finding a tumour in, or involving the base of the bladder, when tilted up with the finger, per rectum; or by the discovery of a tumour at the lower part of the abdomen, in the region of the bladder. But is such tumour malignant or benign? Constitutional symptoms cannot, I think, decide this question; for the so-called *cachexia* of cancer is rarely present, even at an advanced stage of this disease, as affecting the bladder. The patient's general health and aspect is merely that of a person worn down from pain, sleeplessness, and loss of blood. But the general severity of the bladder symptoms may receive additional significance by the detection of cancer-cells in the urine, as revealed by the microscope. Yet the resemblance of cancer-cells to the rudimentary form of vesical epithelium, will render this evidence equivocal; unless, indeed, a mass, or an infiltrated papilla, can be brought to light. In a later stage of the disease, enlargement of the glands in the iliac regions, confirms the diagnosis. The age and sex of the patient should also be taken into account. Thus, scirrhus is more common in men, and between forty-five and sixty years, is the most liable period of life. *Calculus* sometimes coexists with cancer of the bladder,

especially with the encephaloid species ; and here sounding may discover both the presence of a stone, and the nature of the tumour, by the copious hæmorrhage which follows exploration with the instrument.

Cancer of the bladder admits of no curative treatment. But, the anæmic exhaustion can be met, and life prolonged by the judicious administration of a supporting diet and blood-restoring tonics ; the wearing-down suffering can be relieved, and the tormenting vesical irritability can be lulled by opiates and suppositories ; and the resources of experience may yet ease the way, as the plough of pain nears the end of the furrow.

Tubercle of the bladder is a most serious affection, but happily of very rare occurrence. As part of a constitutional disease, tubercular deposit takes place also in other organs ; especially the prostate and kidneys ; and, in females, the uterus is sometimes previously affected. In the walls of the bladder, this deposit appears in the form of small granulations, seated in the mucous coat ; and more often at the base or neck of the bladder. These points may coalesce, but continue in a chronic state for a long period.

This condition gives rise to no peculiar symptoms ; and the diagnosis is determined chiefly by negative considerations. Severe pain and extreme irritability of the bladder, there may be ; but these symptoms are common to other diseases, as the formation of a morbid growth ; yet the absence of obstruction to micturition, and of hæmorrhage in any quantity,—the failure to discover a tumour or stone, will probably lead our

clinical examination from the bladder to other organs, and thence to the constitutional symptoms of tuberculosis.

The progressive emaciation, taken also in conjunction with the age of the patient, afford additional evidence as to the nature of the case.

Softening of the tubercular matter at length ensues, and the mucous membrane gives way, presenting an ulcer of variable size; which has a ragged, undermined margin, infiltrated with the deposit. Tubercular matter is now discharged in the urine, which may be recognised by the eye, or revealed by the microscope. Ulceration sometimes extends so as to destroy nearly the whole surface of mucous membrane; and then a very large, ragged ulcer is found after death.

Treatment must be directed to the constitutional disease; although the supervention of chronic cystitis will also engage the surgeon's attention.

HÆMATURIA.—Blood in the urine, or simply bloody urine, is a *symptom* only, of which disease in some part of the urinary organs, is the cause. The quantity of blood discharged varies; a small proportion, not perceptible perhaps until submitted to microscopic inspection; or an amount which may be so large as to constitute the greater portion of the fluid passed.

Any admixture of blood and urine can hardly fail to be recognised by differences in the *colour* of the urine. A small quantity of blood gives to the urine a brownish or smoky tint, and deposits as a reddish-brown sediment. With a larger quantity of blood, the urine has a dark brown, muddy colour, like chocolate; and a red

sediment falls down, adhering to the bottom of the vessel. When nearly pure blood is passed, the urine appears as such ; and retains nearly the same appearance on standing. On pouring a suspected sample of bloody urine into a test tube, the smoky or darker chocolate tint is even more clearly seen ; heat coagulates the blood into a brownish-grey deposit ; and a drop of the urine under the microscope exhibits the characteristic red blood-discs. Both these tests, and especially the latter, will declare the presence of blood in the urine ; and thus distinguished hæmaturia from simply dark reddish-coloured urine, arising from other causes ; the presence of bile, rhubarb, or other colouring matters, or the mere concentration of urinary secretion.

Having found blood in the urine ; what may be the *source* of that blood, or the seat of the disease ? The blood may possibly proceed from any part of the whole urinary system ; from the kidney, the ureter, the bladder, the prostate, the urethra. But again turning our attention to the state of the urine, as discharged ; the *admixture* of blood, more or less completely, presents certain appearances which may guide our judgment respecting this most important question. When the hæmaturia is renal, the urine will be uniformly mixed with the blood ; when it is vesical or prostatic, the first portion of urine that is passed or drawn off by the catheter, will be pale and less bloody than the last, and at the termination of the stream, pure blood only may escape ; when proceeding from the urethra, the blood may be mixed, but more often unmixed, with urine, it is passed also in the form of worm-like clots or casts of

the urethral canal, and independently of micturition. Many and diverse causes give rise to bloody urine, comprising:—diseases of the kidney, acute and chronic; injury, as blows or strains in the loins; calculus in any part of the urinary tract,—whether in the kidney, ureter, bladder, prostate, or urethra; violent diuretics, as turpentine or cantharides; cystitis occasionally; prostatic disease; cancer of any part of the urinary organs; villous tumour of the bladder; the hæmorrhagic diathesis; certain blood diseases, as typhoid fever, or purpura; stricture of the urethra, urethral chancre, cordee; strong injections.

Treatment.—The cause of hæmaturia,—the disease whence the blood emanates, must of course be taken into consideration with the view to treatment, in each particular case. But certain general directions should always be observed; namely, rest, in the recumbent position, and the administration of astringents. Of the astringents which may be taken internally, gallic acid is, I think, most generally efficacious; but other resources offer, in the form of the mineral acids, acetate of lead and opium in pill, perchloride of iron, and other styptics of known repute. When the hæmorrhage proceeds from the bladder, cold may also be applied, to the hypogastric region, the perineum, or within the bladder by injection. But I am in favour of ice-cold water enemata, as a general rule of treatment in these cases. The management of the blood collected in the bladder, is a question respecting which different opinions are held. The coagulum may be broken up and removed. A full-sized catheter is introduced into the

bladder, and a syringe being applied, the blood is withdrawn by suction; or the bladder can be washed out through a large-eyed double current catheter, using cold water for this purpose. After either method of evacuating the bladder,—and the latter method is preferable,—I am in the habit of using a weak acid injection, to stop the recurrence of hæmorrhage. Generally, however, any disturbance of the clot would seem to be unnecessary and prejudicial. Its removal is apt to re-open the vessels and renew the bleeding; while the solvent action of the urine itself will most safely and effectually bring away the blood. The urgent desire to micturate may be controlled by the moderate influence of opium; and retention of urine can be relieved by gentle catheterism, to prevent any distension of the bladder.

MALFORMATIONS.—The bladder is liable to various congenital malformations, which may be either of three kinds:—(1.) Extroversion of the bladder, arising from a congenital absence of the anterior wall of this organ, with an equal deficiency of the anterior wall of the abdomen, thus exposing the posterior wall of the bladder as a prominent projection; (2.) Absence of the bladder, with certain abnormal deviations of the ureters,—by their direct communication with the urethra, the rectum, or the vagina; (3.) The co-existence of two or more bladders.

Extroversion of the bladder is usually connected with absence of the pubic symphysis, leaving an interval or gap, by which the recti muscles diverge in the lower part of the abdomen. The anterior wall of the bladder

being wanting, the posterior wall bulges forwards in the space between the muscles, and may even form a convex projection, owing to the downward pressure of the abdominal viscera. The exposed mucous surface of the bladder has a bright red, vascular appearance, and presents the orifices of the two ureters, as prominent papillæ, about an inch apart. From these orifices, the urine distils and trickles downwards, perpetually moistening the mucous surface; but in some cases, the ureters having become dilated, the urine is retained in them, and ejected in jetting streamlets occasionally. Below the extroverted bladder, an imperfect penis depends; a short, flattened projection, flattened and cleft, as an epispadias,—showing the floor of the urethra, even as far back as the prostatic sinus and crista galli, with the openings of the ejaculatory ducts. The prostate itself may be absent, but more often is rudimentary, and corresponds to the pubic gap. Below the penis, there is a scrotal pouch of integument, containing the testicles, of small size.

Both sexes are liable to this malformation, but it occurs far more commonly in the male. In the female the external genitals are also imperfectly developed; the clitoris is usually split, and the labia diverge upwards to the integument adjoining the extroverted bladder.

Yet the sexual function may be performed,—*proh pudor*; and in at least two instances, pregnancy has followed, and safe parturition.

In both sexes, the exposed mucous membrane of the bladder is very sensitive and readily bleeds, while the continual distillation of urine produces excoriation of

the parts beneath ; and pervading the unhappy sufferer with a constant odour of stale and decomposing urine, compels him, or her, to lead a life of seclusion. This wretched state is rendered worse, by the absence, in most cases, of the pubic symphysis ; for then, the pelvis being loosened, and the hips widened, the person thus afflicted, can only shuffle about from chair to chair.

Treatment.—It might be supposed that a malformation so sad as an open and protruding bladder, would long since have engaged the attention of the true surgeon, who is always full of compassion, for devising means of relief, be the object ever so loathsome. 'Tis there that the heart most expands and palpitates with pleasure ; even as the Great Master often selected the leprous outcast for the cleansing operation of His mercy. But some years since, the subjects of extroverted bladder were almost unknown to the humble craftsmen of Surgery. As a student at University College Hospital, I remember only one such case ; a poor lad who was shown as a natural or unnatural curiosity, with his little bag for alms-giving ; and who went the round of the Metropolitan Hospitals. As surgical attention has been directed to such cases, patients have presented themselves more frequently at hospitals, and in private practice. *Mechanical* contrivances of various kinds have been devised with the view of forming an artificial abdominal wall over the bladder, to catch the urine as it flows ; thus preventing excoriation and the urinous odour. An india-rubber bag, secured in position, may answer this purpose. But any artificial substitute requires great nicety of fit, and

capability of adjustment to the various positions of the body. Accordingly, the handmaid of surgery—mechanism, has here given place to *plastic* operations,—for the purpose of restoring the deficient abdominal wall and completing, as it were, the urinary bladder. An ingenious procedure of this kind was originally performed by M. Adolphe Richard, in October, 1853; it was founded on one performed by M. Nélaton, for epispadias, in 1852. A few years afterwards,—1859, Pancoast, of Philadelphia, introduced the use of two reversed flaps of integument, taken from the sides of the bladder, and turned with the skin surface towards the bladder. In the same year, Dr Daniel Ayres, of New York, operated on the same principle; but the skin around the margin of the exposed bladder, was dissected up, and brought together by sutures over the raw surface of the reflected flaps. An important modification of the operation has since been practised; the flaps are taken from the groins, at the sides of the bladder; whereby a better supply of nourishment is provided, from the recurrent branches of the common femoral artery, for primary union to take place. Mr John Wood has completed the operation, in all its details, and has been the most successful operator.

The *operation* now consists of two stages; the first to effect the closure of the upper part of the bladder; the second,—after the interval of about a month, to close in the lower part, and to form a prepuce and complete the urethra. Closure of the bladder is accomplished by reflecting two triangular flaps of skin, one

on each side of the exposed bladder, with their bases downwards, and attached to the skin of the groin at Poupart's ligament. The apex of each flap meets the other at the median line above the extroverted bladder, so that the raw surfaces exposed by lifting them are continuous at that point. The inner edges of the flaps are made close up to the bladder, and are brought together in the median line, and united by interrupted wire sutures. The penis may then be fastened down to the scrotum by a silver wire suture passed through the frænum, to allow a free escape of urine. Then the angles of the groin and umbilical incisions are to be united by wire sutures. Completion of the urethra and the formation of a prepuce—according to Wood's operation—"consists, in raising the whole front of the scrotum, together with the skin covering the lower side of the penis—going deep enough to include the muscular layer of the dartos—so that these tissues form a sort of bridge of skin connected with the groin on both sides. This is then lifted over the penis, which the great extensibility of the parts permits easily to be done, and placed upon a bed or raw surface, prepared for its lodgment by turning down a collar or flap from the arched border of the bladder-covering above, and from the sides of the urethra and penis below, as far forwards as the glans. A continuous thin wire suture holds the deeper or reversed flaps together, and a single line of interrupted suture connects the transplanted scrotal structures to the border of the bladder-covering. The gap in the scrotal wall is afterwards easily closed in over the testicles by the great extensibility of the hinder

part of the bag, which is left intact; the margins of the wound being brought together vertically by thickish wire sutures that will not easily cut out."

As to the *difficulties* of these plastic operations, Mr Wood finds;—that in the first stage,—closure of the bladder, the chief difficulty arises from the hernia-like protrusion of the hinder wall of the exposed bladder by the action of the abdominal walls upon the contained viscera. In the second stage—that of forming the new prepuce and completing the urethra, difficulty is due to the occurrence of erections in the imperfect penis, excited perhaps by irritation of the sutures; thus displacing the united parts, or rupturing the newly-formed adhesions, before sufficiently secure to resist tension.

After-treatment.—The former difficulty referred to, is best obviated by a proper *position* of the patient after operation; a sitting posture with the knees drawn up, tied together, and placed over a high bolster. This relaxes the abdominal and pelvic muscles connected with Poupart's ligament, completely, and also allows the urine to drain off by gravitation from the raw and adhering surfaces. Erections are most effectually controlled by *cold* applications, as by irrigation or ice-bags.

Results of Operation.—Considerable success has attended this operative procedure for the plastic repair of extroverted bladder. Richard's case was unsuccessful; death ensuing in nine days from peritonitis. But Ayre's two cases were both successful. So also was another by M. Michel (1868); in the person of a male infant, fourteen months old. Mr Wood records eight

cases of operation ('Med.-Chir. Trans.,' 1869), in none of which was there the slightest approach to peritonitis; and all recovered, except the first, which terminated fatally, but not in consequence of the operation. The success in curing or relieving the malformation, has been variable; sometimes a perfect result, or a complete failure, sometimes a greatly improved condition.

Displacements.—Under this title I propose to notice briefly two forms of Displacement, which as relating to the Bladder are occasionally met with in practice; Prolapsus, and Hernia.

Prolapsus may occur in females, the bladder falling down with the anterior wall of the vagina; in the form of a rounded swelling within the labia, or perhaps appearing externally between the thighs. This tumour is soft and fluctuating to the touch, especially when pressure is made above the pubes; and the transverse rugæ of the vagina may be seen, unless the swelling be very tense. The compressible character, and the size of this vaginal swelling, will vary with the more or less distended state of the bladder; and after micturition, only a lax condition of the vaginal wall may remain. Passing the finger on to behind the tumour, the os uteri may be felt, having a direction downwards and backwards; and this uterine retroversion arising from the bulging tension of the vaginal wall, in front, there can be no doubt that the case is not one of prolapsus uteri, and which is a more common affection. Prolapsus of the bladder is attended with some bearing-down sensation,—stretching even from the navel, when the bladder is full; and constant vesical irritability urges

to frequent and straining micturition ; but with incomplete effect, as the fundus of the bladder still remains full ; and while repeated efforts gradually increases the prolapsus, partial retention of urine at length provokes chronic cystitis. Surgical relief is sought sooner or later, for the bladder is not quiet in any state ; whether moderately full or partly emptied. A catheter is introduced, and then—in addition to the vaginal tumour, and vesical symptoms—the surgeon can plainly feel the point of the instrument in the vagina, when turned down into the fundus of the bladder ; and from which receptacle, a quantity of urine may be drawn off, below the level that the patient could expel. By tilting up the vaginal wall with the fingers, the bladder is readily emptied ; and this natural mode of relief, aided by an inclined position forwards, the patient may herself have learnt by experience.

The *cause* of this prolapsed state of the bladder is soon discovered. The patient has a large, relaxed *vagina* ; which may be the result of anything that has impaired the natural tone of the passage. Commonly arising from repeated pregnancy, and tedious or difficult labour ; this state of the parts is found mostly in women who have borne many children, and in rapid succession. Sometimes also in women who are weakly, and subject to leucorrhœa, the *vagina* is naturally so lax that prolapsus of the bladder seems to be ever impending. But a naturally lax *perineum*, which readily yields under any straining effort, is, so far as I have observed, rather a protective support against the descent of the bladder,—or, indeed, of the uterus.

Hernia of the bladder, alias *Cystocele*, is a displacement of very rare occurrence. The protrusion may take place in either of the ordinary situations, as *inguinal* or *femoral* hernia; but it has been met with also as a *perineal* hernia. A tumour of a softened compressible character, appears,—say in the groin, and descends into the scrotum; thus resembling an intestinal protrusion—an *enterocele*. But certain peculiar and distinctive symptoms may be observed. The size of this swelling is scarcely affected by coughing, and which gives only a slight impulse, nor by the position of the patient, standing up or lying down; the swelling varies in size as the bladder is emptied, and fills again. On compressing the tumour during the act of micturition, or with a catheter in the bladder, the *quasi* intestinal protrusion subsides; but it returns with the re-accumulation of urine. The unaided act of micturition may not reduce the swelling, for the protruded portion of the bladder still remains full of urine; and this partial retention is attended with incessant vesical irritability, and frequent desire to pass water,—another symptom which distinguishes cystocele from intestinal hernia. A *scrotal* cystocele may simulate hydrocele,—both are fluctuating tumours; but hydrocele is irreducible, except when congenital, and then the transparency of the distended tunica vaginalis may contrast with the opacity of a protruded bladder.

Vesical hernia seems to originate in a relaxed and enlarged state of the bladder,—an atonic condition, coupled with the retention of urine. The distended bladder yields laterally, more readily than in any other

direction, and thus reaching the internal abdominal ring, it may partly protrude through the inguinal canal. At first, there is no peritoneal investment—no sac; but when the fundus of the bladder descends, the peritoneal covering presents a sac. Sometimes, an ordinary intestinal and omental hernia co-exists, and this protrusion descends in front of the cystic, behind which lies the spermatic cord. In some cases, the protruded portion of bladder has contained not only urine, but also one or more calculi. With any symptoms of stone, sounding then, of course, will not detect the calculus. When situated in the groin,—as a cystic bubonocoele, the stone has been mistaken for a bubo; an odd mistake, considering all the different circumstances of the two cases.

The *treatment* of cystocele is simply that of hernia; the protrusion should be reduced, and kept up by a truss; or when irreducible, a suspensory bag must be worn.

In the event of an operation, the surgeon will remember the peculiarities of the hernia with which he has to deal;—the absence, usually, of a peritoneal sac to the bladder; and the possible co-existence of an intestinal hernia, with a sac, overlaying the cystocele. Should the vesical protrusion contain a stone, this must be returned into the cavity of the bladder; and afterwards removed by lithotomy or lithotritry.

INJURIES.—The bladder, lodged within the bony walls of the pelvis, is less liable than many other organs to external injury, as wounds or rupture; and only occasionally, to the intrusion of foreign bodies from

without, through the urethra or by gun-shot penetration; but it is very commonly the receptacle of urinary concretions or calculi,—which from both a clinical and surgical point of view constitutes a subject of such interest and importance, that I shall devote the next chapter to its special consideration.

Laceration of the bladder occurs not unfrequently with fracture of the pelvis, this additional injury being a most serious complication, in consequence of the extravasation of urine. An open wound, as by a bullet, may allow the urine to escape externally, and recovery has been known to ensue.

Rupture of the bladder is also not very uncommon, as the result of blows, kicks, or contusions on the lower part of the abdomen, especially when the bladder is fully distended and rises above the pubes in contact with the abdominal wall. Thus, this accident may happen from a fall in wrestling, the uppermost man coming down upon his antagonist, or from running against a post in the dark, an instance of which Liston relates. In that case, a large calculus, which nearly occupied the bladder, was shattered into fragments by the concussion.

The *symptoms* of a lacerated or ruptured bladder can scarcely fail to attract attention. The patient is seized with a sudden and intense pain in the lower part of the belly, with immediate collapse, and inability to pass water, or only a little bloody urine comes away through the urethra; all these symptoms having arisen from some such injury as we have already noticed. On introducing a catheter, the bladder is found to be

empty, or a small quantity of bloody urine is drawn off. In gun-shot injury implicating the bladder, the urine may perhaps be seen to escape through the track of the wound. Extravasation of urine is more or less perilous, according to whether it takes place into the peritoneal cavity or into the cellular tissue of the pelvis; this difference depending on the situation of the rent in the bladder, as above or below the reflexion of the peritoneum. In the one case, fatal peritonitis speedily ensues; in the other, diffuse cellulitis, and a less rapid and surely fatal termination.

Treatment must be directed to the immediate prevention of yet further extravasation of urine. A full sized gum-elastic catheter should be passed into the bladder, and retained by tapes; that the urine may dribble away as fast as it descends into the bladder. Any appearance of urinary infiltration presenting externally, must be at once met by free incisions, so that the noxious fluid shall escape, and sloughs also as they form. This prompt interference may succeed in circumscribing the infiltration, and in time for a barrier of lymph to be thrown out, ere the supervention of blood-poisoning. Peritonitis is less under control; for although the catheter commands the bladder, the urine already extravasated and imprisoned with the peritoneal cavity, still maintains the inflammation. The general treatment consists in the watched administration of opium and stimulants, with whatever nourishing food the stomach will accept, to sustain life through the long course of exhaustion.

Rupture of the ureter is a rare kind of injury, but it

has been known to occur from external violence, and recovery is altogether hopeless. In a case recorded by Mr Stanley, a large collection of urine formed around the rent in the ureter, as a circumscribed and fluctuating swelling, which was repeatedly tapped. Ruptured pelvis of the kidney, in another case, led to the formation of a similar cystic collection of urine behind the peritoneum ; and no less than six pints were drawn off, at one sitting. But the patient died about ten weeks after the accident.

Foreign Bodies. — Various foreign bodies, such as portions of catheters, bits of pencil or tobacco-pipe, a hair-pin, and all sorts of odd things, too numerous to mention, are occasionally thrust into the bladder through the urethra. Both sexes have indulged in such practice, whether from some feeling of idle curiosity or morbid propensity. Any substance thus introduced is usually of some length, and lying perhaps across the bladder, is rarely expelled in passing water ; it must, therefore, be extracted surgically. This may sometimes be accomplished with a lithotrite, by catching the body in its long axis, or by crushing it as a stone ; but it has been found necessary to have recourse to the operation of lithotomy. Knowing the size and shape of the foreign body, the median operation can be more frequently selected. But no operative procedure need be taken immediately, unless bladder-symptoms are urgent ; for sometimes the foreign intruder is ejected through the urethra, and when least expected, even more easily than it entered. Having failed to extract a hair-pin from the bladder of a young

woman,—after crushing the calculus-concretion around it, and fully dilating the urethra, the pin, thus relieved, worked its way out on a favorable opportunity. The male urethra is, of course, a less convenient channel for the natural discharge of any substance from the bladder.

Bullets, bits of clothing, or other bodies are sometimes lodged in the bladder by gun-shot wounds, implicating this organ. Any such body must be removed as circumstances permit. Mr Dixon has collected fifteen cases where the ball had entered the bladder, either in the first instance, or in consequence of abscess and ulceration; and in ten of these cases, the ball was extracted by the operation of lithotomy, with successful results. Of the remaining five cases, the issue is not recorded.

Whatever may be the kind of foreign body in the bladder, it soon becomes encrusted with calculous deposit; and by thus increasing the difficulty of its extraction, while as a persistent source of irritation, chronic cystitis supervenes, the result of any operative procedure may be unsuccessful.

Worms of various species have, in rare instances, been discharged from the urinary bladder. How they get in and how they creep out, is part of their natural history. The *ascaris lumbricoides* or round worm, and the *a. vermicularis* or thread-worm, both of which species inhabit the intestine, may escape through a recto-vesical fistula. The *strongylus gigas*, occasionally infesting the kidney, passes down the ureters. The *spiroptera hominis* were discharged from the bladder of a patient, for a period of thirty years, whose case is

mentioned by Sir W. Lawrence; and many of the *dactylius aculeatus*, a small round worm, were voided from the bladder of a female child, in a case authenticated by Mr Curling. Hydatids also have been known to travel out by the urethral passage. But the surgeon may be glad to turn from things which are rare and curious, to resume the course of experience that concerns him, far more commonly, in the practice of his art.

CHAPTER III

URINARY CALCULUS—LITHOTOMY AND LITHOTRITY

I now approach a subject around which, as a central figure in Surgery, has gathered a vast array of detail, and the difficulty lies, not in the exclusion of much which might be introduced, but in the selection of that which will best exhibit a faithful view of the whole; just as an artist desires to catch the lineaments of his attractive model, that he may at least present a portraiture true to life. The descriptive representation of the subject on which we are entering, may be taken from my general work on 'Surgery;' but the picture, as it were, will be finished more completely, by throwing in much practical detail, more suitable to the character of this special treatise.

Urinary calculus signifies a concretion of one or more of the constituents of the urine, forming a hard mass or stone. The *production* of such calculus will be noticed in connection with the pathology of urinary diseases; but the seat of origin may be either in the kidney or the bladder, giving rise to calculus,—*renal* or *vesical*. Usually, it originates in the kidney, and subsequently descends through the ureter, as a small stone, into the bladder, where it increases by further concretion.

RENAL CALCULUS.—A stone forming in the pelvis of

the kidney may, or may not, be attended with pain or other symptoms of nephritic irritation. Frequently, it remains quiescent and unsuspected when lodged in this dilated portion of the ureter. It may there attain a large size and remarkably irregular shape, being moulded to the pelvis and calices of the ureter within the hilus of the kidney. Absorption of the kidney-substance results from the continued pressure, and this is attended with pain in the lumbar region and symptoms of nephritis. In rare cases, abscess has been known to ensue, and the stone discharged through an aperture in the loin.

A *small* stone in the pelvis of the kidney usually descends through the ureter into the bladder; it gradually increases in size, as a vesical calculus, by accumulating concretion on its surface.

The *descent* or passage of a renal calculus is accompanied with more or less severe pain and constitutional disturbance, in proportion to the size and shape of the stone. A small, smooth stone may descend without occasioning any notable suffering. A larger-sized and rough stone, as a mulberry calculus, descends with much difficulty, and causes proportionate agony. After, perhaps, some symptoms of nephritic irritation, the patient is seized with sudden and excruciating pain in the loin, extending down the course of the spermatic cord to the testicle, which is often retracted, and down the thighs. This agony may double-up the patient, and make him roll on the ground, vainly seeking and imploring relief. It is worse to bear, and to witness, than the pain in passing a gall-stone. Bloody urine,

. vesical irritability and frequent micturition, with vomiting and constitutional irritation, are the additional symptoms of a descending renal calculus, and which simulate acute nephritis. But the constitutional disturbance is not febrile, the pulse remaining comparatively unaffected. These symptoms continue, with several remissions, from generally twelve to twenty-four hours—the usual period occupied by the descent of a renal calculus; when, on its entering the bladder, all the symptoms suddenly cease. This origin, course and character, and termination of the symptoms determine the diagnosis. Sometimes, the calculus remains impacted in the ureter, and symptoms of calculous pyelitis supervene. When the stone has become vesical, and is lodged in the bladder, the symptoms of stone in the bladder ensue.

Treatment.—Only palliative measures are available. Opium is the most efficacious anodyne for assuaging the nephralgic pain, and the patient can be kept under its influence during the whole period of passing the stone. Chloroform may, however, be administered with advantage, from time to time, as a relaxant. The warm bath is also a most serviceable adjunct. Cupping in the loins, followed by warm fomentations, may afford some relief. The bowels should be thoroughly emptied by mild oleaginous enemata, and diluent drinks freely allowed.

STONE IN THE BLADDER.—A stone, *loose* in the cavity of the bladder, falls into the most dependent part, behind the prostate; but it shifts about according to the varying posture of the patient. The *symptoms*

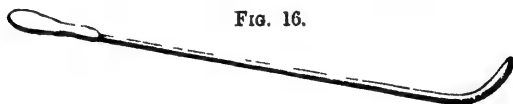
produced, arise from the mechanical irritation and the obstruction caused by the stone as a foreign body in the bladder. They are always essentially the same in kind, though modified in degree in different cases, and may be comprised under four heads; pain, chiefly in the glans penis; irritability of the bladder with increased frequency of micturition; obstruction occasionally to the passage of urine; and morbid conditions of the urine, bloody urine in particular. In addition to these four symptoms, which severally may arise from other causes than stone; there is the physical sign of a hard body elicited by *sounding* the bladder with a metallic instrument, whereby a stone can be felt and heard when struck,—the sensation and sound as of a stone being transmitted through a metallic instrument to the hand and ear. This touchstone, as to the presence of a calculus, is conclusive, when available; and it alone is far more diagnostic of stone than all the mere functional symptoms of its presence.

Taking these symptoms in the order mentioned, their respective *characters* must be noticed more particularly. The *pain* is that of a dull weight about the neck of the bladder, and perhaps an uneasy sensation extending to the lower part of the abdomen, the perineum, or thighs, or even to more remote parts, as the knee, heel, foot, or arm; but the pain shoots along the penis and centres in the *glans*. Here the pain is more acute, and it is aggravated *after* each act of micturition, when the stone settles down on the more sensitive trigone vesicale of the bladder behind the prostate. In consequence of this pain in the glans penis, children acquire

the habit of constantly handling and pulling the prepuce, whereby it becomes enlarged and elongated; the recumbent position also is often sought instinctively in passing water, to relieve the recurring attack of suffering. The *vesical irritability* and frequent desire to evacuate the bladder, are in like manner aggravated *after* micturition; for as the urine is strained off by an urgent effort, the stone settles down on its sensitive bed. Micturition, therefore, is not unfrequently spasmodic and involuntary. The semen may be ejected at the same time, and sometimes with troublesome priapism; and there is a tendency to prolapsus of the rectum, in consequence of the oft repeated straining and spasmodic efforts to relieve the bladder. When the bladder is empty, any movement of the body will be more or less communicated to the stone, which rolls about with every change of posture. Personal experience soon restrains the sufferer's movements. Exercise is avoided, and he shuns any sudden or violent exertion; the pain is increased also by any jolting motion, as in jumping, riding, or driving. The *urine*, passed frequently, and in small quantities at a time, may flow freely, in a full stream; but it is ever liable to *stop abruptly*, owing to the stone being washed forward suddenly against the neck of the bladder, thus closing the urethral orifice. The *character* of the urine changes. It becomes clouded and sometimes loaded with mucous or muco-purulent deposit, which may clear off as the bladder gets reconciled to the presence of a stone. But it is more often tinged or streaked with blood, sometimes amounting to vesical hæmorrhage; and this

symptom may continue for a long period. *After* micturition or any rough exercise, bloody urine is more apt to occur, from attrition of the stone and interior of the bladder.

Sounding the Bladder.—A *sound* is a solid steel instrument, shaped like a catheter; but with a shorter curve, and having a bulbous extremity, and a broad, flat, smooth handle (Fig. 16). It should be smaller

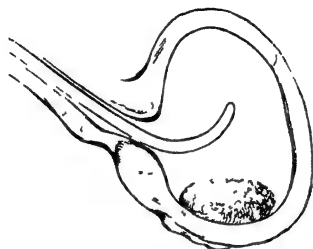


than a full-sized catheter, this reduction and its shorter curve enabling the instrument to be freely turned about in the bladder; while its somewhat enlarged extremity may aid in detecting the stone, and its expanded handle render the sensation communicated more perceptible to the touch. A proportionately smaller instrument, and with an abrupt curve, will be suitable for children, in whom the bladder is situated higher up in the pelvis than in adults. Sounds of various sizes and curvature will be required for different cases.

Sounding is performed in the following manner:—The bladder containing three or four ounces of urine, or having been distended to that amount by injection with warm water, and the patient lying in the semi-recumbent position; the instrument is warmed, conveniently by slipping it up the arm of the operator for a few seconds, then well oiled, and passed gently along

the urethra into the bladder (Fig. 17). Its cavity

FIG. 17.



is explored, first along the inferior surface by raising the handle of the sound and passing its convexity from the neck of the bladder in a sweep backwards; then, the bladder should be explored laterally, by revolving the handle from side to side between the fingers and thumb; lastly, the instrument should be withdrawn to the neck of the bladder, and the point turned downwards to the depressed space behind the prostate, and then upwards to behind the pubes. The space behind the prostate may sometimes be advantageously tilted forwards by introducing the finger into the rectum; a proceeding chiefly requisite in old persons.

In all these manœuvres, the instrument is used with a gently tapping motion, in order to strike the stone. It should be remembered that the bladder is often very sensitive, and disposed to bleed, owing to long-continued irritation; so that anything like rough manipulation would be unsurgical. Even the patient may be acutely sensitive, and would undergo the shock of injury, from any such use,—or abuse, of the instrument.

“ Ah ! ”—was the remark I once heard—“ pain is *pain* to me.” Failing to discover a stone in the recumbent position, the bladder should be sounded with the patient standing up, and with a more or less than moderately distended state of the cavity. These resources having failed to present the stone, a second exploration may be made in the course of a few days.

The knowledge gained by sounding comprises more than the fact of the presence of a stone. Its *situation* is generally found to be on one side of the neck of the bladder, more frequently to the right; or when small-sized, it usually lies backwards towards the fundus or buried in the space behind the prostate. (See Fig. 17.) Its *size* is less clearly ascertainable, but this may be guessed by observing the extent of hard surface over which the sound passes and the readiness with which the stone is found in all conditions of the bladder. By introducing a lithotrite, the dimensions of the calculus can be measured in all directions, as indicated by the separation of the blades. The *shape* of the *surface*,—whether rough or smooth, is tolerably perceptible to the touch; and the *density* or hardness of the stone can be estimated almost precisely by the sound elicited on percussion with the instrument—by, in fact, *sounding*. A hard calculus, as the oxalate of lime or uric acid calculus, rings when struck, so as to communicate a click audible to a bystander at perhaps a distance of some yards off; a soft calculus, consisting of phosphates, conveys a dull earthy sound, perhaps scarcely audible to the operator. The grating rough sensation and slight sound of a fasciculated bladder, perhaps overlaid with

phosphatic deposit, must not be mistaken for a distinct calculus.

A second calculus, or the presence of several calculi, can sometimes be distinctly detected by the sound, a stone perhaps lying on each side of the bladder; the introduction of a lithotrite will, however, surely determine the question, when one stone is seized and another struck with the instrument still holding the first in its grasp. Sir H. Thompson has devised and employed a modification of the lithotrite, which acts as a sound, catheter, and measurer. It goes by the name of Weiss's catheter-scoop with stop-cock.

Sounding is an operation not wholly free from danger. It may induce cystitis and peritonitis, terminating fatally. Sanson, Civiale, Crosse, and others have recorded such fatal cases. With all possible lighthandedness in sounding, severe cystitis is sometimes provoked; as happened in a case where Dr Gross had sounded a young man, who was, however, the subject of stone of twenty years' duration, and accompanied with chronic cystitis.

All the symptoms of stone are more or less *pronounced* according to the size and shape of the calculus, as a foreign body in the bladder. A large-sized stone is usually attended with more marked symptoms; and an irregular rough stone is productive of the most severe symptoms. The kind of calculus has some influence, but chiefly as depending on the constitutional diathesis. The quality of the urine will also affect the severity of certain symptoms; a highly acid or alkaline state of the urine having a stimulant action on the

interior of the bladder, the pain and vesical irritability are aggravated. Lastly, the condition of the bladder itself, when inflamed, whether by irritation of the calculus or its continuance, has a similar influence on these symptoms. Phosphatic calculi imply a previously disorganised state of the bladder or chronic cystitis, and thence the accompanying local and constitutional disturbance of this state.

On the other hand, sounding may *fail* to discover the presence of stone, and such instances have occurred in the hands of the most experienced Surgeons; as Cheselden, Pelletan, and Dupuytren. In some cases, *large* calculi, of the size even of a hen's or duck's egg, nearly filling the bladder, have escaped the most careful and minute examination; instances of which are related by Verzascha, Benevoli, Duretus, Riverius, Marcellus Donatus, Chesneau, Valentin, Riolanus, Morgagni, Covillard, Tolet, Morand, Deschamps, and Chopart, and by Gross as having occurred in the practice of Sir B. Brodie. *Several* calculi cannot always be detected; Collet extracted from the bladder twenty-two previously undiscovered calculi, which were hard and the size of a hazel-nut. Failure has occurred also after *repeated* exploration, as in the hands of Abernethy, who thus failed to discover a large, rough, oval calculus. In some such cases, the stone has remained undiscovered for years, until *after death*. An instance of this kind I remember to have heard from the late Mr Thomas Morton (Surgeon to University College Hospital) as having happened in his own practice; an instrument had been constantly passed also by many eminent Surgeons

during a period of fifteen years, and yet no stone was found until after death. In other cases, and not unfrequently, a stone may be distinctly felt at one time, and not at another; a remarkable instance of which fell to my own lot. I had distinctly touched a small stone, lodged apparently in the *cul-de-sac* behind the prostate, and it was also felt by other Surgeons; yet, a few days afterwards, when about to operate, I could not detect the stone as the patient lay on the table, nor could it be discovered by Mr Coulson, sen., or by Mr. Gutteridge; the latter skilled lithotomist having explored the bladder in various states of distension and the patient standing up. About a month afterwards, the patient came to me with the stone in his hand; he told me that he had been seized with an intolerable desire to pass water, and as if the passage would burst, when the stone suddenly shot out and rolled across the room. Lastly, a calculus may be found *apparently*, by sounding; and then the unhappy mistake has been made, of cutting for stone and finding none. This misadventure has, however, happened to the most experienced Surgeons; to Cheselden, who on three occasions cut and found no stone, Crosse also, Roux, and Dupuytren, each of whom have thus performed abortive operations. Velpeau was acquainted with four such instances; S. Cooper knew of seven; and Coulson can refer to at least seven cases, at two of which he was present, where patients have been subjected to lithotomy, with the absence of any stone in the bladder.

Encysted calculus is so named when the stone is

lodged in a cyst or pouch of the mucous membrane, between the muscular fasciculi of the bladder. The symptoms of stone—as caused by a loose, hard body rolling about in the bladder, are necessarily *absent*. There may be some pain and weight, with increased frequency of micturition, arising from the irritation of a foreign body; but there cannot be any aggravation of these symptoms after each act of micturition, and much increased by any jolting exercise—the stone being stationary; nor any sudden stoppage of the stream of urine, and constant liability to the admixture of blood. Then again, sounding gives less positive evidence as to the presence of a stone. The encysted condition may be suspected; if the stone be struck just once in a way,—when its exposed surface is hit by chance, and if it be always found at the same part of the bladder; or if the stone can sometimes be easily felt and at other times not felt at all,—owing to its escape occasionally into the bladder and back again into the cyst. A large encysted calculus having been struck, may perhaps be defined with the bulb of the instrument; not as an isolated stone, but through the mucous membrane as a projecting tumour. This comparative absence of symptoms occurs also when a calculus, at first loose in the bladder, *afterwards* becomes encysted.

Diagnosis.—The symptoms of stone, taken *severally*, may, when *present*, be due to other diseases of the bladder. A pedunculated growth in the bladder is apt, during micturition, to flap over the urethral orifice and thus abruptly arrest the flow of urine. Ulceration

of the prostate, or malignant disease of the bladder, both give rise to hæmorrhage. Lastly, the pain and vesical irritability may be sympathetic of an impacted and inflamed testicle within the inguinal canal, in the more rare case of undescended testis. We should therefore not be misled by the presence of any one symptom, but be guided by an *association* of the symptoms in respect to urinary calculus, as in the diagnosis of nearly all other diseases. Even the positive evidence afforded by sounding will often be masked when the prostate is enlarged. And, as Sir B. Brodie first observed, the last mentioned symptoms, pain and vesical irritability, are often much diminished by this prostatic condition; owing probably to the enlargement protecting the more sensitive neck of the bladder from the weight and friction of the stone. *Difficulties*, and sources of *fallacy*, in the way of sounding may be thus enumerated: a large and deformed bladder; a contracted bladder, unable to contain fluid; a sacculated or encysted bladder; an irregular hour-glass contraction of the bladder, obstructing the passage of the sound into one of the compartments; calcareous matter adherent to the walls of the bladder; calculi in the prostate and urethra; enlarged and roughened prostate; and tumours at the neck of the bladder. The calculus itself may be coated with blood or mucus.

In the *female*, the symptoms of stone are similar to those in the male. Sounding is very easily accomplished, the straight and short urethra readily admitting the instrument and exploration of the bladder. The

sound should, therefore, be shorter and less curved. By introducing the fingers into the vagina, the stone can be tilted forward, thus facilitating the examination.

Consequences, and Terminations of Stone in the Bladder.—The bladder, prostate, ureters and kidneys, undergo important structural changes, chiefly of a destructive character. With these changes in the urinary apparatus, exhaustive constitutional disturbance ensues. The *bladder* becoming extremely sensitive, especially behind the prostate where the calculus commonly rests, the urine is expelled at short intervals, and a contracted state of the bladder results. Sometimes, however, it falls into an atonic and dilated condition, with retention of urine, which undergoing decomposition assumes an ammoniacal and offensive character. In either state, more particularly the latter, chronic cystitis frequently supervenes, subject occasionally to attacks of acute cystitis, with muco-purulent urine. A fasciculated condition of the interior of the bladder usually results, in consequence of an hypertrophied development of the muscular bands beneath the mucous membrane; and not unfrequently between these fasciculi a hernial protrusion of the mucous membrane occurs, forming a pouch or cyst, in which the calculus is apt to lodge, as an encysted calculus. An ulcerative and discoloured sloughy state of the mucous membrane sometimes sets in; or a parietal abscess may form, which opening into the bladder, may receive the stone into its sac, and thus the calculus becomes encysted. Perforation of the bladder has been known to happen, allowing the stone to escape into the peri-

toneum, or perhaps into the rectum, vagina, or perineum. Pelvic cellulitis sometimes occurs, with diffuse suppuration. These more extreme results have probably been induced by injudicious sounding. The *prostate* usually becomes in some degree enlarged, whereby a depression or pouch forms behind it, as a frequent receptacle for the stone. The *ureters* undergo less marked changes; generally they are somewhat dilated, and thickened by chronic inflammation, especially at the pelvic portion adjoining the kidney. This organ is the seat of the most serious and ultimately fatal disorganization. Thus, the *kidneys* may be affected with chronic nephritis; and sometimes with the acute form of this disease, terminating in suppuration and a speedily fatal issue by uræmia or pyæmia. Degeneration more commonly takes place as the consequence of chronic nephritis, and death results from albuminuria.

This, the ordinary course of stone in the bladder extends over a longer or shorter period of years; varying very much according to the kind of calculus, the constitution, and age of the patient. Nevertheless, the course, although more or less slow and the symptoms more or less severe, is always progressive in its tendency to a fatal issue. As a set-off to this mode of termination, a spontaneous cure now and then takes place, by the expulsion of a small stone through the urethra in the act of straining micturition; and far more rarely, the stone has been ejected by ulceration of the bladder through the rectum, vagina, or perineum.

Treatment.—The *remedial*, as well as the *preventive*,

treatment of vesical calculous affections, comprises those measures—medicinal and hygienic—which have reference to the calculous diathesis, in each particular kind of urinary deposit; a subject reserved for special consideration with Urinary Diseases. The various morbid conditions of the urinary organs, resulting from the presence of calculus as a foreign body—chiefly irritability of the bladder, and cystitis—have already engaged our attention.

Operations.—The treatment of Stone in the Bladder consists of the various *operative* procedures appropriate for the removal of Stone. Three methods have been devised, two of which are established operations; (1) lithotomy or the extraction of stone by a cutting operation; (2) the removal of stone mechanically by instruments, without a cutting operation—as by lithotritry or crushing in the bladder and extraction piecemeal through the urethra, or sometimes by simple dilatation of the urethra; (3) solution of stone by chemical agents or lithontriptics, or by the agency of electricity—electrolysis. Having regard to the desirability of these several methods of procedure, it might seem proper to notice the latter, or removal by solution, first; but in consideration of the far superior efficacy of the other two methods, they will be described almost exclusively; and first lithotomy, as being the operation perhaps most generally applicable.

LITHOTOMY, or the operation of cutting for stone in the bladder, has been performed in various ways; both as with regard to the seat of operation and the method of its performance. There are three situations in

which the bladder may be entered;—in the perineum, the supra-pubic or hypogastric region, and through the rectum; thus indicating three principal operations of lithotomy—perineal lithotomy, the supra-pubic or high operation, and the recto-vesical operation. Perineal lithotomy comprises *four* varieties; (1) the ordinary *lateral* operation of Cheselden, and as modified in detail by Key, Liston, and other modern lithotomists; (2) the *median* or Marian operation, revived by Vacca, and as modified by Civiale, Buchanan, and established in modern surgery by Allarton; (3) the *bilateral* or transverse operation of Dupuytren; (4) the *quadrilateral* section of the prostate by Vidal de Cassis.

No branch of Surgery possesses a history more interesting, curious, and romantic, than that of lithotomy, and its comparatively recent substitute—lithotrity; and nowhere is the temptation so alluring to an author in love with his theme, to trace the gradual development of surgical principles and their application in practice. But I must postpone this digression to another opportunity.

Preparation of the Patient for Lithotomy.—Some Surgeons, as Key and Coulson, have paid great attention to the state of the patient's constitutional health preparatory to operation; other Surgeons of equal eminence, as Liston, have not deemed it necessary to delay the operation by much preparation. The nervous system being tranquil, or subdued by an occasional opiate, the skin acting freely, and the urinary secretion having been corrected, as far as possible, by alkalies or

acids, according to the character of the calculus; the bowels should be well relieved by mild purgatives, and the rectum especially must be emptied by an enema of castor oil and gruel on the morning of the operation. On no account should the operation be performed until the enema has come away, the loaded state of the bowel much increasing the liability of wounding this part.

Instruments.—Certain arrangements, which although simple, are indispensable to the safe performance of lithotomy. A firm, even, operating table, lightly covered with a doubled blanket so as not to present any thickness into which the buttocks might sink unevenly; a piece of waterproof covering being placed over the blanket, of sufficient length to hang down over the end of the table. Pillows are requisite to support the back. A firm stool is the most convenient seat, and it must be of such height relative to the table, that the patient's buttocks shall be level with the operator's breast when he sits down. This adjustment is easily made by experience. A small low table or a large chair should be provided, on which the instruments are laid out; and placed to the right of the operator, so that he can readily help himself during the operation, independently of any assistant for this purpose. The appliances and instruments requisite are:—a pair of bandages of coarse flannel, each about three yards long and two inches in width; two lithotomy knives or scalpels; namely, a sharp-pointed, straight-backed knife, and a blunt button-pointed knife, somewhat curved backwards towards the end; a staff, boldly

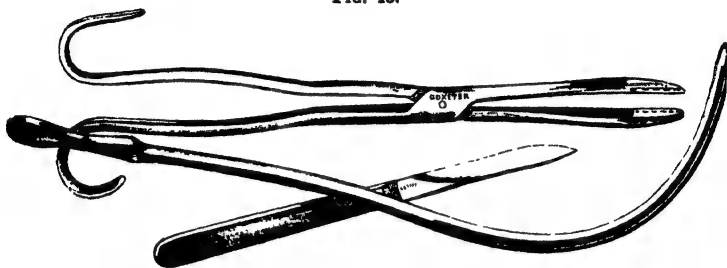
curved and deeply grooved on its left side with a good pit at the end of the groove, the size of the instrument being sufficient to fill the urethra, and the handle roughened; lithotomy forceps, straight and curved; scoops of different sizes; a bladder-searcher; and an injecting syringe, capable of holding about a pint, the nozzle fitting to a catheter. To these might be added, a gum-elastic urine-draining tube with rings at its outer end, whereby it can be fixed in the bladder with perineal tapes, after the operation. This instrument was invariably used by Liston, for apparently important reasons to which I shall presently refer; it has also been employed by other excellent lithotomists, and as a Listonian pupil, I naturally followed for a time the example of the great master. But the tube was, I believe, seldom used by Coulson, nor by other men of large experience, and it has now fallen into general disuse.

Lateral Operation.—Four assistants at least are required for the performance of this operation; one to administer chloroform, one on each side of the patient to fix the perineum in the proper position as presently described, and a fourth to take charge of the staff. A fifth assistant might be convenient to hand instruments, unless they are placed within easy reach of the operator, when sitting down.

The operation consists in cutting on a staff into the bladder,—by a preliminary superficial, perineal incision to reach the instrument, followed by a deep or prostatic incision in the groove of the staff to enter the bladder; and the extraction of the stone. Thence the

instruments essentially requisite, are simply three; a staff, a knife, and forceps (Fig. 18).

FIG. 18.



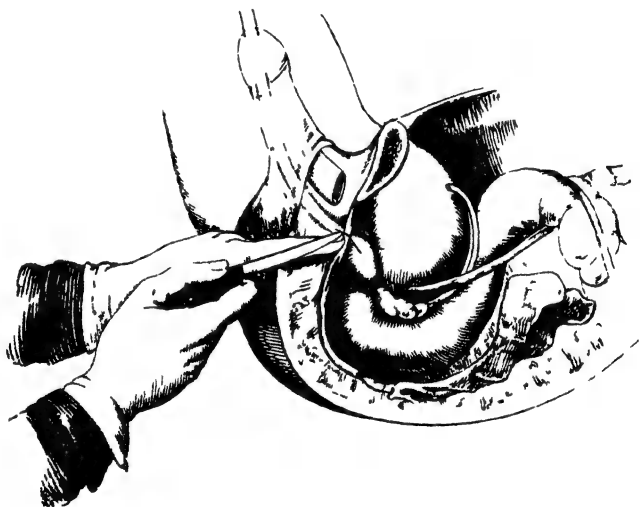
The patient is placed recumbent on the table, and chloroform administered. Then the bladder having been previously emptied of urine, should be injected with tepid water to the amount of about six ounces, in order to steady the bladder and expose the stone to the grasp of the forceps. Sounding should now be performed, immediately before the operation is commenced,—when the patient's bladder is in position. This may be done with an ordinary sound; but it is preferable to at once introduce the staff of sufficient size to occupy the urethra—and, using it as a sound, the stone must be distinctly felt and its situation ascertained. This is an imperative rule in regard to lithotomy. If the stone cannot be felt at the time of operating, the operation should be unhesitatingly postponed; if it can be felt, the operation is proceeded with. The patient is brought to the end of the table, so that his buttocks resting on the edge shall project a little beyond it; the legs are to be drawn up and the hands and ankles firmly bound

together with the lithotomy bands, as thus,—either hand being placed on the outer side of the ankle and made to grasp the foot, both are securely joined in this position by a figure-of-8 application of the band. I prefer this security to the couplet leathern straps which are sometimes used. Then, the side-assistants, taking each a foot in his hand on the inner aspect of the foot, and placing the patient's knee in his axilla, the limbs are drawn sufficiently apart to fully expose and throw out the perineum; at the same time observing that it inclines to neither one side nor the other, but is fixed perpendicularly, or horizontally to the table, and maintained in this position throughout the operation. Unless these two assistants attend only to this, their simply mechanical but important duty, that of exposing and balancing the perineum, instead of attempting to hang over and see the operation, they will assuredly disturb the visual line of the operator and thus embarrass him in his incisions and manipulations.

The staff is now given in charge of an assistant, standing on the patient's left, with the injunction to hold it firmly, in the perpendicular direction, or inclining slightly *downwards*, and hooked up against the symphysis pubis. In the annexed Fig. 19 from Liston's Practical Surgery—the identical wood-engraving being here used—the inclination of the staff is shown; but the curve of the instrument is depressed, instead of hooked up under the pubic symphysis. Some surgeons prefer that the convexity of the staff should be made to bulge slightly forward in the perineum; others that it

should be turned somewhat towards the left of the perineum ; while some prefer that it should be depressed, and held in contact with the stone. The assistant holds the staff between the thumb and the fingers of his right hand ; the left hand is used to raise the scrotum from the raphé running

FIG. 19.



down to the rectum. Thus then, the space between the urethra and the rectum is exposed as much as possible, so that the one can be more readily approached without the risk of wounding the other.

The surgeon seating himself on the stool in front of the exposed perineum ; he shaves the integument on the left side, and introduces his finger into the rectum to know for certain that the bowel is empty and to

induce its contraction ; whereby any remaining feculent matter will be expelled, and the contracted state of the bowel diminishes the risk of its being wounded during the deeper incision. Then, with his left hand thumbing the tuberosity of the ischium and the ramus on the left side, he feels also, with the point of the fore-finger, the sort of depression below the bulb of the urethra, in the middle line or raphé, which lies over the curve of the staff ; a point about one inch and a half in front of the anus, rather lower than higher, and corresponding to a part of the instrument which in a thin perineum can often be plainly felt. The land-marks of his incision having thus been clearly defined ; the Surgeon rests his left hand on the right half of the perineum, so as to make the skin on the left side slightly tense, and indicating with the fore-finger the above spot, he plants the lithotomy-knife in the raphé or just to the left of it, and carrying the blade in a straight line obliquely downwards and outwards, midway between the anus and tuberosity of the ischium, or somewhat nearer to the latter, terminates the incision at a point just below the anus. A *free* but superficial *perineal* incision is thus made. The length of this incision will be from three inches to three and a half, in the adult ; its extent varying somewhat according to the size of the perineum, and the apparent size of the stone. The skin, superficial fascia and fat are divided ; but the depth of the incision, varying according to the perineal obesity, is above rather less than an inch, while below, the knife sinks a little more deeply into the ischio-rectal fossa. The upper half of this incision

—above the anus, leads to the staff; the lower half,—by the side of the anus and below it, facilitates the extraction of the stone. The point of the fore-finger of the left hand is now drawn firmly from the upper angle, along the bottom of the wound, between the left erector penis and accelerator urinæ muscle overlaying the bulb of the urethra, so as to separate these parts; then, using the finger to protect the rectum, by pressing it somewhat downwards and to the right, any further resisting structures are divided by a slight touch or two with the knife. Thus are divided, the transversalis perinæi muscle and artery, and the base of the deep perineal fascia or triangular ligament of the urethra, which latter sometimes in elderly persons presents a tolerably firm bar to the finger. The finger is then directed upwards from the rectum, as a guide to the staff; the groove of the staff is felt just in front of the prostate, in the membranous portion of the urethra, and as covered therefore with this membranous structure stretching across the groove. By a little compression at this spot, the nail of the finger is lodged fairly in the groove; and then the point of the knife, with the cutting-edge downwards, is slid along the finger *over* the nail, and penetrating the membranous urethra, is at once inserted into the groove of the staff, and felt to touch the metal, the contact with which may be further assured by a slight lateral movement of the point. This relative position of the finger to the knife will securely protect the rectum,—itself also pressed downwards and to the right; and which, from its proximity beneath the prostate, is especially liable to be wounded at this

part of the operation,—the commencement of the *deep* or *prostatic* incision (Fig. 19.) The knife is now pushed firmly along the groove of the staff, through the prostatic portion of the urethra and the prostate, with a slight inclination of the blade downwards and outwards; thus incising or notching the prostate *laterally*, in the same direction as the external or superficial incision; while the point of the blade, by slightly depressing the handle to a very limited angle with the staff, follows the curve of the staff, until the bladder is entered. If the knife directed sideways, runs firmly in the groove of the staff, so as not to slip out to the left, the blade cannot go wrong and the incision must be right. The bladder is known to be entered by resistance ceasing, and perhaps a gush of water taking place. This incision may be made rapidly and boldly by a practised lithotomist; a less practised lithotomist must take the incision more slowly and cautiously. A *button-pointed* lithotomy-knife may perhaps be used more safely, as it locks into and has a more secure hold in the groove of the staff. Such a knife was always employed by Coulson. It is introduced into the groove of the staff, after a small puncture, to the extent of three or four lines, has been made into the membranous urethra by the sharp-pointed knife, in the perineal incision. I have never yet thought it necessary to use this instrument.

This—the deep or prostatic incision, is therefore *limited* in its *extent* through the *prostate*; not exceeding twice the width of the blade of the knife, and certainly not passing beyond the base of the gland, where its

capsule prevents infiltration of urine into the cellular texture of the pelvic cavity behind the prostate. In withdrawing the knife through the prostate, it should pass over the finger, in the same direction as in introducing it, and still in the groove of the staff, so as not to enlarge the incision; at the same time, the finger is pushed forward through the prostatic incision into the bladder; and, if this manœuvre be executed adroitly, the introduction of the one follows the exit of the other,—the finger replacing the knife *before* the water escapes in any gush from the bladder. The finger, fitting into the incision, is made to enlarge the wound by a sort of twisting, or tunnelling motion; whereby the opening is dilated and the prostate somewhat split, as with a blunt gorget, instead of having been cut freely by the knife. As the finger proceeds,—the stone is felt for. This double duty of the finger, as a dilator and a searcher, may be conveniently performed, while the Surgeon is taking the forceps with his other hand from an assistant, or from a basin of warm water at his side. Having entered the bladder, and found the stone; the assistant is directed to withdraw the staff. Then the Surgeon introducing the closed blades of the forceps over the finger, he slides them into the bladder, and opens the blades, withdrawing the finger, at the same time; a gush of water now takes place,—if not previously, in making the prostatic incision—and thus the stone may sometimes be washed into the grasp of the forceps; or, on somewhat dipping the forceps, with a sort of sweep from left to right across the fundus of the bladder, the stone

is at once caught and seized, whereby the instrument feels suddenly locked. Failing to catch the stone, in either of these ordinary ways, it should be gently sought for, and touched, with the forceps. It may then be seized by one of two manœuvres, as in lithotritry; by depressing the inferior fundus of the bladder with one blade, and giving a slight shake, the stone will probably fall into the grasp of the instrument; or by passing the blades along the side of the stone, then opening them, and turning the opened blades over to that body, it will be seized almost with certainty. The size of the stone may be estimated by observing how far the handles are separated. If it seem to be seized in its long diameter and too large for extraction; the stone may be shifted by a jerk of the forceps, or disengaged and reseized, so as to be extracted without lacerating or bruising the neck of the bladder.

Extraction should be performed slowly, and by working the instrument gently backwards and forwards to gradually dilate the prostatic aperture; bearing down also in the direction of the axis of the pelvis, in order that the widest part of the arch of the pubes may be available for the extraction, and the lower part of the perineal incision which facilitates this concluding part of the operation. The forceps lie in the axis of the pelvis, and are withdrawn, in the same direction as obstetric forceps. If, as a rare event, the stone slips from the forceps, when it has been withdrawn through the prostate, it cannot be reseized under the pubic arch, or without disturbing the cellular connections of

the bladder and rectum ; the finger should be passed into the bowel, so as to fix the stone from behind, and then with the scoop it may be drawn or tilted out of the wound. After removing the stone, the finger should be reintroduced into the bladder to search for any other stone which may be present ; or the *searcher* can be used for this purpose to reach parts of the bladder not readily accessible to the finger, as in front above the pubes. And, as *in* the act of withdrawing the knife through the prostatic incision, the finger at once followed it forward, so also *in* withdrawing the forceps, the finger is again made to follow this instrument ; that thus the entrance to the bladder shall never be lost—an injunction the more imperative when the staff, as a guide, has been withdrawn. No second stone having been discovered, the operation is completed.

Fracture of the stone sometimes occurs, in seizing or in extracting it ; and generally as the result of undue force in using the forceps, aided perhaps by the brittle character of the stone, as when the calculus is phosphatic. This accident should be carefully avoided ; for the fragments are apt to injure the bladder in any attempt to extract them, and it necessitates the repeated introduction of an instrument. The fragments are best removed by means of the *scoop*, with the forefinger resting on the end of this instrument to keep the fragment from slipping out of the bowl. The bladder should then be thoroughly washed out with tepid water, injected by a strong brass syringe through a tube introduced by the wound. Several

small calculi are most readily removed in like manner—by the scoop.

Lastly, a gum-elastic tube may then be introduced through the wound into the bladder, and retained in position by perineal tapes. This instrument was formerly deemed serviceable for two purposes; as a means of arresting any oozing hæmorrhage; and for keeping the wound free of coagula, thus affording a clear passage and preventing the infiltration of urine. But the latter risk is surely avoided by the limited prostatic incision; and the former advantage is more than counter-balanced, in most cases, by the incessant concentration of the patient's attention to his bladder. Originally, I believe, recommended by Collot; Liston, I know, always used this tube, so did Sir W. Fergusson, in his earlier operations, and Mr Spence still patronises it; but the instrument was condemned by Velpeau, and restricted in Mr Coulson's practice to cases attended with a disposition to hæmorrhage, or employed by Sir B. Brodie only when there was a liability to infiltration of urine, either from clot-formation in the wound or from laceration beyond the prostate in the extraction of a large stone; and the employment of the tube is now generally abandoned in this country.

I have thus described the lateral operation of lithotomy as consisting of three steps; two of which are incisions—a superficial or perineal, including a deeper touch or two with the knife, and the deep or prostatic incision; and then, seizure and extraction of the stone from the bladder. It should, however, be observed by

the Student, that although these steps are described separately, as in detail, they are performed successively as one continuous operation. The procedure consists in an *alternate* application of the left fore-finger and the knife, or the forceps. Commencing with the indication of the point for entering the knife in the perineum, this is followed by the superficial perineal incision; then, the finger is used successively, as a protector, guide, blunt-gorget, and searcher; with the knife alternately, in the perineal wound, the groove of the staff in the membranous urethra, and the prostate; followed by the forceps, also used alternately with the finger, in the bladder. The textures are successively divided downwards and outwards, away from the rectum, by *lateralized* incisions; and they together form an oblique *conoidal* wound, having its base externally in the perineum, and the apex in the prostate. In the *limited* extent of the *prostatic incision*, the operation, as described, differs essentially from that of the earlier and some living lithotomists;—Frère Jacques, Cheselden, Desault, Klein, John Bell, Martineau, Come, Souberbielle, Langenbeck, Gutteridge, and other most successful operators; who made a free prostatic incision, extending even through the neck of the bladder; but the limited incision has been advocated by Pierre Franco, Le Cat, Scarpa, Dupuytren, Callisen, Sir A. Cooper, Sir B. Brodie, Crosse, of Norwich, Key, Stanley, Liston, Skey, Coulson, Syme, Spence, Sir W. Ferguson, and by the most experienced modern lithotomists in this country, supported by Dr. Gross, and other distinguished American surgeons.

Position of the Hand and Knife.—Much difference of opinion has been held in surgical works of authority, and different delineations have been given, as to the manner of holding the knife in lateral lithotomy. In making the superficial or perineal incision, the knife is generally held *under* the hand; and in making the deep or prostatic incision, *this* position is still maintained by lithotomists, and as shown in works on Surgery. Liston, however, would appear to have held the knife *above* the hand, in making the latter incision, as depicted in Fig. 19. It is described as being a representation of “the position of the hand and knife,” at the commencement of the second incision, as shown “in a very correct sketch of the viscera of the pelvis, with their relative size and position; and which has been copied more than once without acknowledgment.” (Fourth Edition, 1846, p. 509.) But, notwithstanding this record by Mr Liston, on the point in question; as an old Hospital pupil, having enjoyed unusual and repeated opportunities of witnessing the operations of the great lithotomist, I can corroborate the personal knowledge of Mr Cadge, of Norwich, that Mr Liston held the knife *under* the hand, like other lithotomists; and I particularly well remember also that, in entering the point of the knife into the groove of the staff, his fingers were enclosed around the blade, apparently to cover the edge, and fit the point into the groove securely, the instrument being then sent forward from the palm of the hand. But although there can be no doubt that in the Listonian operation of lithotomy, the hand and knife had the usual relative position, and *not* as represented in the

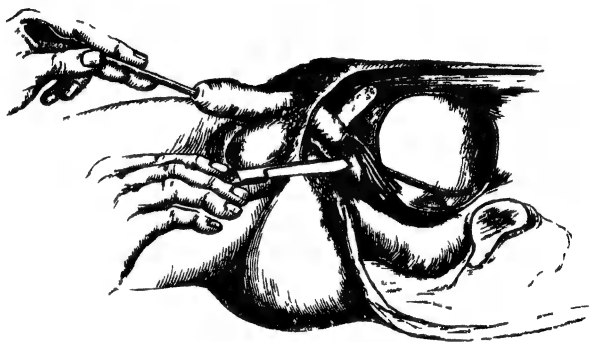
Fig. 19 ; yet I am now equally certain from my own experience of the operation both on the living and dead subject, that the method actually depicted in that Fig., will be found generally more advantageous ; the point of the knife being thus directed *upwards*, whereby it is kept more securely in the groove of the staff. The slight inclination of the staff downwards from the perpendicular also facilitates the passage of the knife in the groove ; as in "cutting on a straight staff," without entailing the special risk incident to the manipulations in that mode of operation.

Cutting on a Straight Staff.—This mode of performing the lateral operation was originated by Aston Key, at Guy's Hospital, where it is still practised, and by other Surgeons. The curved staff, as a director for the knife, is ill-adapted in its form to guide the point with safety, just where the use of the staff becomes requisite,—in making the prostatic incision. This disadvantage may be overcome by cutting on a straight staff ; and the advantage is also gained, that the groove, which had been directed downwards for entering the knife, can then be turned in any oblique line for division of the prostate. But the straight staff is more liable to be tilted out of the bladder than the curved one ; and therefore, the end of the staff should always rest upon the stone in performing the operation with this instrument.

Having reached the staff by the perineal incision, which has to be carried deeper than to reach the curve of the ordinary staff, the point of the knife is entered into the groove ; then the Surgeon, withdrawing the

left forefinger from the wound, takes the staff from the assistant previously in charge, and depressing the handle brings it down parallel with the axis of the pelvis, so as to present a direct passage to the bladder (Fig. 20). In doing either of these acts, special care

FIG 20



(Bryant)

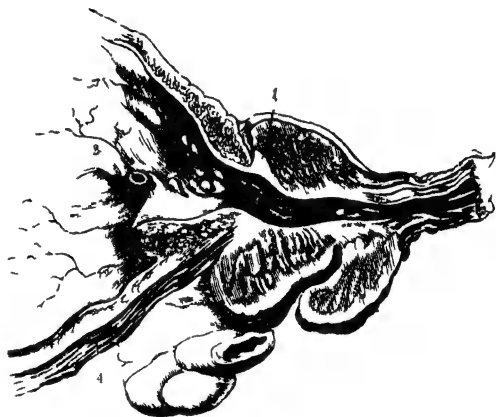
must be taken lest the knife slip out of the groove. Feeling certain that it still remains in ; the Surgeon lateralizes both staff and knife, in contact, to the left of the perineum, corresponding to the external incision, and pushes the knife onwards along the groove into the bladder ; withdrawing it in the same direction, so as to incise the prostate only to a limited extent. Here again, in this nearly parallel mode of using the staff and knife, special caution must be taken lest the point be tilted out of the groove by the front of the prostate ; when, instead of entering the bladder, it would pass

down into the pelvic cavity. This may be obviated by depressing the handle of the knife to a *limited* angle with the staff, so as not to incise the prostate too far back. Then, having entered the bladder and withdrawn the knife, this instrument is laid aside; the staff is now transferred to the right hand, and the left forefinger, introduced into the wound, is guided by the staff into the bladder and to the stone. The finger resting on the stone, the staff may be withdrawn; the forceps is introduced along the finger, and the operation completed.

Parts cut, and Parts to be avoided, in Lateral Lithotomy.—If the operation be conducted on the principles laid down, the question of the “parts” concerned, is more an anatomical investigation than a surgical consideration—more a Student’s question, than of practical consequence. The parts necessarily *divided*, in their order from without inwards, are;—the skin, superficial fascia and fat, with the inferior hæmorrhoidal vessels and nerves passing across the ischio-rectal fossa; the transverse perineal muscle and artery, with probably the superficial perineal artery and nerves; the base of the triangular ligament and the deep transverse urethral muscle; the membranous urethra and constrictor muscle; the prostatic urethra, and the prostate to a limited extent in its left lateral lobe, including the “ligamentous ring or band” around the neck of the bladder, but not the capsular boundary formed by the reflexion of the recto-vesical portion of the pelvic fascia; external to the capsule, some of the anterior fibres of the levator ani muscle will be divided, and

within the capsule, a plexus of rather large-sized veins must be severed—in the prostatic incision.

The annexed figure (Fig. 21) represents the “parts cut in Lithotomy,” as depicted in Liston’s ‘Practical Surgery.’



(Marshall)

FIG 21 —1 and 2, fibrous band around the orifice of the bladder. 3, opening of ureter, 4, descending muscular fibres, with transverse fibres towards the cavity

The parts to be *avoided* in the operation, are in anatomical works thus enumerated;—the rectum, the internal pudic artery, where it courses forwards under cover of the ramus of the pubes; the bulb of the urethra; and the artery of the bulb, which normally passes inwards transversely about half an inch above the base of the triangular ligament, between it and the other or deep layer of the perineal fascia. Of these parts, the *rectum* will be avoided, by having the staff

well hooked up, protecting the bowel with the finger and lateralizing the knife parallel with the bowel—particularly in an old person whose rectum is commonly dilated into a pouch just above the anus, sometimes even wrapping around the prostate from side to side. The precaution of emptying the bowel should also be observed. The arterial vessels mentioned are less readily wounded; but, when presenting anomalies, they may be unavoidable. The *pubic* artery will be avoided by not turning the knife too much outwards in making the deep incision. Posteriorly this artery is securely lodged under cover of the *tuber ischii*; but, occasionally, it descends over the inferior surface of the bladder, and across the prostate to reach the penis. Or, the accessory *pubic*, as an occasional substitute for the *pubic*, when defective, lies on the posterior edge of the prostate; it may then be avoided by not extending the prostatic incision backwards to the base of the gland. The *artery* of the *bulb*, a serious source of hæmorrhage, may perhaps be avoided by not cutting too freely upwards towards the groove of the staff; but an irregular course of the vessel, lower down than usual, cannot be foreseen or avoided by any plan of incision. Sometimes also, as arising from the obturator artery, or as a branch from the artery of the bulb on the opposite side, neither of these anomalies can possibly be anticipated. Lastly, the *bulb* of the urethra, a source of venous hæmorrhage, may be avoided by directing the point of the knife obliquely upwards beneath its projection, in the act of penetrating the membranous urethra. I agree, however, with Mr

Skey, in not attaching much importance to a wound of the bulb; and I have no doubt it not unfrequently happens without any evil consequence. The venous plexuses, within the capsule of the prostate, are sometimes much enlarged, especially in old men, and become a source of unavoidable hæmorrhage.

For years I have protested against fettering the hands of the Operator with many of the impracticable considerations laid down in *Anatomico-Surgical works*. In lithotomy, Anatomy plans the landmarks and limits of the incisions—perineal and prostatic; but the *pathological* conditions of the prostate and of the bladder are of more surgical importance in the seizure and extraction of the stone. This will appear presently in connection with the difficulties incidental to the operation.

The Lateral Operation in Children.—Lateral lithotomy is performed in the same way in Children as in Adults; but the anatomical condition of the parts under the age of puberty and especially in childhood, affects the performance of this operation. The anatomical peculiarities alluded to are chiefly four; the looseness of the perineal cellular texture in the recto-vesical space; the small size, thinness, and weakness of the membranous urethra; the rudimentary small size of the prostate; and the position of the bladder—it being situated higher up or more in the abdomen than in the pelvis. These conditions severally affect the operation in its first part—that of entering the bladder; extraction of the stone is not attended with any special difficulty.

Thus, the superficial perineal incision having been

made correctly, the *loose cellular texture* easily yields and gives way under the finger, forming a distinct, smooth-walled cavity or false bladder, in the rectovesical space; which resembles the interior of the bladder. A very little groping with the finger, in the wrong direction—*downwards*, will form this deceptive cavity; into which the finger readily enters as if into the bladder. Perhaps also the membranous urethra has been penetrated, whereby the urine dribbles away and the bladder gradually collapses; both circumstances apparently confirming the belief that the finger is really in that cavity. Indeed, the latter condition affords more room for the easy enlargement of the false bladder. In this anxious and perilous moment, two points of distinction should be remembered; this false bladder presents *no neck* through which the finger should pass to gain admission, nor can the *bare* grooved staff be felt along the back of the finger when introduced into the cavity. Besides both these negative features of distinction; *above* this cavity, near the symphysis pubis, lies the staff leading to the bladder; and which can be plainly felt on directing the finger from the scene of mischief, obliquely upwards to that spot. Hence, the practical inferences are these; in approaching the staff, to avoid making anatomy by a too free use of the finger as a guide; and to direct both it and the knife upwards to the more highly situated staff, instead of heedlessly slipping into and working in the interval between the bladder and rectum. A precaution before operating should also be observed; that of sufficiently distending the bladder with water, to lower

its position in the pelvis, and to steady its neck. The same kind of misadventure may occur between the neck of the bladder and the pubes, by misuse and misdirection of the finger *upwards*. It need scarcely be added, that in either such case, the little patient remains unrelieved, and dies with the stone in the bladder. Yet this calamity has happened to some of the most skilful and experienced lithotomists—past and present.

Again, in endeavouring to hit the membranous urethra and lodge the point of the knife in the groove of the staff; the urethra being of *small size*, it may be so cut about as to be nearly severed from the prostate. Or, if the point of the finger be not insinuated well into the opening, or if any undue force be used in passing it into the bladder, the *thin* membranous urethra may be torn across, and the neck of the bladder driven backwards on, or off, the staff,—an accident more likely to happen when the urethra has been nearly severed.

Thus then, in opening the urethra, as in approaching it, *fiddling* with the knife must be avoided; and in both procedures, any *forcible* use of the finger will also be mischievous.

The *rudimentary size* of the prostate, and the *high position* of the bladder, will both necessitate a more upward direction of the point of the knife, in making the prostatic incision. And it should be remembered that this incision must necessarily almost always, if not invariably, extend through the whole of the small prostate, in its left lobe; yet without any evil consequence.

In entering the neck of the bladder, the feeling is that of passing through a small ring; without riding over the sort of chestnut-like projection upwards of the prostate, and which may be like a half-orange in an elderly man.

When the prostate has been detached from the membranous urethra and the neck of the bladder recedes before the point of the finger, all the presence of mind and dexterity of the Surgeon will be required at this trying moment of peril and anxiety. Much will depend on whether the staff still remain in the bladder, as a guide. If so, the forefinger should be passed most cautiously and gently along the groove, and a slight hooking-movement made at the neck, so as to draw down this part. It may then be notched, by insinuating the knife along the finger, which can thus be fairly entered. If the staff be out of the bladder, or has been withdrawn, the position of both patient and Surgeon is most critical. It may be possible to reintroduce the instrument, and then proceed as just directed. Failing to accomplish the first step, the attempt to hook down the neck of the bladder should never be resorted to,—in the absence of a *guide*. The finger or any searching instrument will only pass deeper and deeper with increasing damage, and inevitable death result. Moral courage is here the better part of valour, and any further operative interference should be resolutely abandoned. The urethra may heal, restoring the continuity of the canal, when the operation can be repeated and brought to a happy issue.

The *Difficulties* which may occur in the performance

of the lateral operation relate either; (1), to entering the bladder; or (2), to seizing and extracting the stone. The first occur more especially in operating on children, and have been already described; the second kind of difficulties are met with more commonly in adults. Thus, in *children* two difficulties are very liable to happen, in endeavouring to enter the bladder; the formation of a false bladder in the recto-vesical space, and the incised or torn detachment of the neck of the bladder from the membranous urethra. In *adults*, the first of these difficulties has occurred as the result of prolonged *boring* with the finger in the cellular interval between the bladder and rectum.

(1) A *deep perineum* presents obstacles to *entering* the bladder. The depth of perineum may be due to fat, in a corpulent person; or to an enlarged prostate, in an elderly person. Both conditions not unfrequently coexist, coupled also with an indurated state of the prostate. A forefinger of average length can perhaps scarcely reach the bladder, if at all; and the prostatic condition of enlargement and rigidity obstructs the introduction of the finger. The blunt-gorget, formerly in ordinary use, is here very appropriate; as affording the means of dilating the incomplete incision in the enlarged and indurated gland, and of gaining access to the bladder beyond reach of the finger.

(2) *Seizure and extraction* of the stone may present difficulties dependent on several conditions;—depth of the perineum, particularly when due to an Enlarged Prostate; an Encysted, or an adherent state of the stone; the Position, Size and Shape of the stone;

Rickety deformity of the pelvis, in its antero-posterior diameter, or by narrowing of the pubic arch. These various conditions interfere with the use of the forceps; either in introducing the instrument into the bladder, in seizing, or in extracting the stone.

Enlargement of the Prostate, which places the bladder beyond reach of the finger, renders the introduction of the forceps difficult; and seizure of the stone more so, owing to the liability of its falling into the depression behind the prostate, and thus escaping the sweep of the forceps; but the latter difficulty may be overcome by using long curved forceps, at the same time endeavouring to raise the stone by passing the finger into the rectum, if the fundus of the bladder can be reached behind the enlarged prostate. In dilating the prostate, a myomatous or prostatic glandular tumour has been enucleated; and this condition, which Professor Gross has met with on several occasions, is said to delay the closure of the wound. In extracting the stone through an enlarged prostate, some difficulty may be experienced; and rather than bruise or lacerate the parts, it would be proper to incise the opposite side of the prostate towards the tuberosity of the right ischium, forming a bilateral section of this body, without making any additional perineal incision.

Encysted calculus is not very common; but if this condition be found in exploring the bladder with the finger, the course to be taken by the Surgeon should depend entirely on the size of the aperture of the sacculus. A small aperture will preclude the possibility of removing the stone, without endangering life. A

large opening, or a partially encysted condition, may allow the stone to be liberated. This can sometimes be effected by a fortunate catch with the forceps; in one case, by Collot, changing the position of the patient proved successful in dislodging the stone; in another, by Sir B. Brodie, the orifice was enlarged with a probe-pointed bistoury, and the calculus turned out with the finger or scoop. The latter procedure is, obviously, extremely hazardous, since the bladder might easily be cut through into the peritoneal cavity. When, therefore, the calculus cannot be otherwise removed, and with tolerable facility, the operation should, as Coulson observes, be abandoned. Sir A. Cooper removed an encysted calculus, in the case of a child, without opening the bladder in the usual manner; passing his finger into the rectum, the stone was felt and struck with a sound, then by introducing a knife through the perineum above the bowel, the cyst was opened, and the stone extracted.

Enveloping folds of mucous membrane are sometimes met with, the stone thus eluding the grasp of the forceps. This mechanical difficulty must be overcome by manœuvre with the forceps, or by the more direct and safe means of the finger and scoop. An insufficiently injected bladder would be more likely to present this difficulty.

Hour-glass contraction of the bladder, the stone being placed in the upper compartment, will probably necessitate recourse to the high or supra-pubic operation of lithotomy.

An *adherent* state of the calculus has been doubted

by some lithotomists; but an indisputable case is recorded by Mr Shaw in the 'Transactions of the Pathological Society,' vol. vi. The adhesion of the mucous membrane to the stone was effected by fibrous tissue, the fibres dipping into the calcareous substance; and this union was so firm that it resisted separation by tearing with the forceps. In extracting phosphatic calculi, the deposit of rough calcareous matter on the rugæ of the bladder must not be mistaken for a distinct calculus; any attempt to remove the former would of course prove disastrous by tearing away the mucous membrane with the deposit.

Position of the Stone.—Two parts of the bladder, in either of which the calculus may be situated, offer considerable difficulty to *seizure* of the stone. When lodged in a depression behind an enlarged prostate, the stone must be brought up by tilting the bladder with the finger introduced into the rectum, and then using a long curved pair of forceps or a curved scoop. When situated above the pubes anteriorly, towards the upper fundus of the bladder, the stone must be lowered by compressing the abdomen, as Aston Key recommended, and then seized with a curved forceps or the curved scoop. In one such case, Sir B. Brodie found the stone both encysted and adherent. Raising the pelvis will sometimes enable the forceps to grasp the stone, a resource which proved successful in a case on which Mr Coulson operated.

Shape and Size of the Stone.—The shape of the stone may offer some difficulty to its *seizure* with the forceps. A round irregular stone, as a mulberry calculus,

is grasped less readily than a flattened, smooth stone, which lies easily within the blades of the forceps. Irregular shaped, phosphatic calculi, present the greatest difficulty.

Both the shape and large size of the stone may offer considerable obstacles to its *extraction*. Three resources are practicable ;—(1) section of the right lobe of the prostate, forming the bilateral section of this body ; (2) crushing, splitting, or drilling and breaking up the stone in the bladder—by means of strong lithotomy forceps, cutting forceps or lithotrites,—thus performing perineal lithotrity ; (3) the recto-vesical, or the supra-pubic operation of lithotomy. Of these procedures, section of the prostate is most practicable and the safest. It was recommended by Martineau, Liston, Stanley, and Coulson, rather than use undue force in attempting to gradually dilate the ordinary prostatic incision, which would cause bruising or laceration. The forceps still grasping the stone is held fast by an assistant, and the right lobe of the prostate is then incised towards the right tuber ischii, by passing the knife or a blunt-pointed bistoury along the blade of the instrument as a director. In this way, Martineau often enlarged the opening, repeating the incision two or three times. Crushing the stone in the bladder through the perineal wound, is a more dangerous procedure ; the instrument required must be of some size and strength ; its application may be attended with some injury to the bladder, which is often firmly contracted on the stone ; and the fragments of stone, as sources of irritation or centres of

secondary calculi, must be thoroughly removed by repeatedly injecting and washing out the bladder with tepid water. This resource is, as Coulson remarks, an operation of lithotrity performed under most unfavorable circumstances. The recto-vesical, or the suprapubic operation would be preferable to crushing, in most cases.

Fracture of the stone is apt to happen when the calculus is brittle, or soft; breaking into several sharp fragments, or squashing into a soft mortar-like mass. It occurs mostly to phosphatic calculi. This breaking-down of the stone results usually from too firm a grasp with the forceps; either lest the stone should slip away, or by pulling too high up and coming in contact with the pubic arch, or in consequence of the pressure requisite in extracting a large-sized stone. The fracture generally leaves a central stone in the blades of the forceps, which should be extracted; and the detached fragments removed by the repeated introduction of this instrument or the scoop, and the bladder thoroughly washed out. Detritus will probably still remain, and small fragments may be discharged through the wound for some days; then the bladder should be injected daily through a catheter passed down the urethra, and the water made to escape freely by the wound; the stream carrying with it particles of calculus. This plan should be continued until no more detritus is brought away. If the wound has healed, the fragments remaining may perhaps be washed out through the urethra, by means of a catheter, as after lithotrity; or, after crushing them, the detritus will

probably escape in the act of passing urine, from time to time.

Rickety deformity of the pelvis, although not a common cause of difficulty in lithotomy, may present insuperable obstacles in extracting the stone. If the brim of the pelvis be narrowed in its antero-posterior diameter, the difficulty of extraction will be increased in children, owing to the high position of the bladder. Narrowing of the pubic arch, which is always narrow in children, may quite preclude extraction, or even the introduction of the forceps. These conditions should be ascertained *before* operation, and supra-pubic lithotomy performed.

The *Accidents* which sometimes happen during the lateral operation are:—(1) wound of the rectum; (2) hæmorrhage, arising either from the vessels necessarily divided, or from the pudic artery or the artery of the bulb, or from certain accidental deviations of these vessels, and from the prostatic or other veins; (3) wound of the bulb; (4) missing the urethra and entering the bladder beyond the prostate; (5) penetration of the posterior part of the bladder from within its cavity.

The three first named accidents have already been adverted to in considering the parts to be avoided in performing the lateral operation.

(1) *Wound of the rectum* is important according to its size or situation. The accident is more likely to occur in old persons, as Deschamps observed,—the rectum being dilated, and even wrapped around the prostate on either side. A small puncture, low down

near the anus, may be left to itself; a little feculent fluid escapes from the perineal wound for some days, along with the urine; but as granulation closes up, this ceases, and the urine is transmitted through the urethra. A larger-sized aperture, or when situated higher up the bowel, had better be dealt with at once and in the same way as fistula in ano. The bowel should be laid open into the perineal wound, by an incision from the accidental aperture downwards through the sphincter ani, so as to form one cavity. Granulation from the bottom may then restore the continuity of the bowel. Otherwise a recto-vesical fistulous communication will remain.

(2) *Hæmorrhage* must be managed on ordinary principles; by ligature or torsion of any distinctly bleeding artery that may be accessible; or by pressure. The artery of the bulb is the principal source of serious, or even fatal hæmorrhage; and so also would be the internal pudic, as it can scarcely retract within the obturator fascia overlaying it; but this vessel is well protected under cover of the ramus of the ischium. Either vessel is best secured by compression; ligature being inapplicable in most cases, as the vessels cannot thus be reached. Compression is applied most effectually by means of digital pressure; provided the bleeding vessel can be commanded with the finger, and relays of assistants are at hand. In the course of fourteen or twenty-four hours, according to cases related by South and Brodie, continued digital pressure has succeeded in permanently stopping hæmorrhage from these vessels. The ramus of the bone offers an excellent counter-resist-

ance to the finger. Ligature has been applied to the internal pudic by Sir B. Brodie, and by Dr Physick, of America; the former surgeon using a flexible silver needle. *Oozing* hæmorrhage, of a persistent character, may be effectually arrested by plugging the perineal wound. This is precisely the condition in which Liston's gum-elastic tube may be used with advantage, while free vent also will thus be given to the urine. The track of the wound is plugged with dossils of lint around the tube; or more conveniently, by pieces of sponge introduced into a conical bag of oiled silk attached to the tube, as devised by Mr Hilton. The tube is kept free of coagula by the occasional introduction of an oiled feather. *Venous* hæmorrhage, proceeding chiefly from the prostatic plexus of veins, may be arrested in like manner. Hilton's contrivance has here proved very successful. A case is related in the 'Medical Times,' 1855. Sir B. Brodie lost a patient within a few hours after operation, from venous hæmorrhage; every effort having been made in vain to arrest it. *Retrocedent* hæmorrhage, the blood, arterial or venous, passing back into the bladder, sometimes occurs and to an alarming extent. Bloody urine escapes by the wound, but the bladder becomes distended; there is dulness on percussion above the pubes, and the patient becomes faint. Injections of cold water should be used to wash out the bladder; and ligature or plugging applied, according to the nature and source of the hæmorrhage.

(3) *Wound of the bulb* is an accident of no serious consequence. This opinion was held by Mr Skey, and certainly it would seem to be confirmed by the frequency

with which the bulb has been wounded with impunity. But the accident has been known to induce phlebitis and pyæmia.

(4) *Missing the urethra, and entering the bladder beyond the prostate*, allows of infiltration of urine into the pelvic cellular tissue. Diffuse inflammation and death will almost necessarily follow. Yet this fatal accident has occurred, once in a way, to the most skilled lithotomists. To avoid it, the nail of the left forefinger should be lodged fairly in the groove of the staff, before planting the point of the knife, over the nail.

(5) *Penetration of the posterior part of the bladder*, is liable to occur from passing the knife too deeply along the groove of the staff; the point may slip out and penetrate the posterior wall of the bladder. Hence the advantage of the button-headed bistoury. An insufficiently injected bladder would be more exposed to this accident. I have never yet known it to happen, although I have heard of such a case.

In *children*, the accidents specially incident to lateral lithotomy, have been fully considered in describing the operation as performed before puberty or at an earlier period of life.

AFTER-TREATMENT.—When no accident has occurred during the operation, the treatment after lateral lithotomy is simple. The patient is placed on his back in bed, with his legs apart and the knees somewhat raised on pillows. The urine will thus drain away through the wound, as it is secreted; preventing the chance of urinary infiltration. A draw-sheet covered with Mackintosh cloth, having been previously placed under

the buttocks, will enable the nurse to keep the patient clean and dry without altering his position. No dressing is required, a sponge or small spittoon-pot is placed under the wound against the nates to catch the urine as it drops. *If* Liston's gum-elastic tube has been passed up the wound into the bladder, and there retained by perineal tapes; this channel can be kept free from coagula and open for the distillation of the urine, by occasionally introducing an oiled feather. When I was a student, this precaution was observed so diligently, that the dresser in attendance sat by the patient's bed-side, the night after operation, for the purpose of thus freeing the tube. It was retained for about twenty-four hours, in a child; and about forty-eight hours, in an adult. By that time its retention was thought unnecessary; the sides of the wound having become glazed over with lymph, whereby the risk of infiltration will have ceased. An opiate should be given, and repeated when necessary, to secure sleep or at least quiescence; and diluent drinks allowed plentifully, with light fluid food, as milk, arrowroot or beef tea, during the first three or four days. In an elderly person, it may be requisite to soon have recourse to stimulants. *Retention* of urine sometimes occurs, and must be instantly relieved by passing a gum-elastic catheter or the finger up the wound to the neck of the bladder. Warm fomentations and opiates will then allay pain and irritation. About the fourth or fifth day, the urine may suddenly cease to escape through the wound, and be discharged through the urethra;—the patient “wets,” as nurses are accustomed to understand it. This, how-

ever, seems due to a temporary turgescence in the wound, resulting from inflammatory swelling which occludes the outlet; subsiding in a day or two, the urine again escapes by the wound. The same temporary discharge of urine through the natural passage may happen at an earlier period,—within twenty-four hours after operation. It is not at all a favorable sign. Urine having again returned through the wound, the quantity gradually diminishes during contraction and granulation; a portion passes permanently by the urethra in a week or ten days, and the wound closes about the end of a fortnight to three weeks. The cure is completed in from thirty to forty days. In the case of a large mulberry calculus which I removed from a man sixty-five years of age, the patient returned sound to Hastings, at the end of a month. Another man, aged 49, was convalescent and returned home on the eighteenth day,—by his own urgent request. But although the wound may have healed at an unusually early period, it is not desirable that the patient should resume his occupation before firm consolidation has taken place. There have been instances in which the neck of the bladder has given way, and a temporarily most successful issue thus converted into a fatal result. Phosphatic calculi generally entail the longest period for recovery after operation.

Morbid conditions of the wound, as that of sloughing or suppuration, must be treated accordingly.

Secondary hæmorrhage not unfrequently occurs; apparently, as Sir B. Brodie suggests, from the detach-

ment of a slough. Compression of the bleeding vessels will here prove more effectual than ligature.

Urinary fistula sometimes remains, with incontinence of urine, temporary or permanent. This result is met with mostly in children, and it generally ceases as age advances. The fistulous tract may perhaps be closed by occasionally passing a probe coated with nitrate of silver, or by the galvanic-wire cautery. *Incontinence* alone may result, particularly in childhood, if the patient be allowed to get up too soon, before the sphincter of the bladder has recovered its tone. *Impotency* is a more rare consequence of the lateral operation from wound or injury involving the ejaculatory ducts in the substance of the prostate. *Fæcal fistula* may issue from a wound of the rectum; or from bruising of the bowel, either by a forcible use of the finger in the act of protecting it, or during extraction of the stone.

I pass on to graver considerations in the history of lateral lithotomy; and some of which will be found to determine the question of operation in favour of its modern rival—lithotrity.

The principal *causes of death* are :—(1) Age; (2) Large Calculus and Pelvic cellulitis; (3) Disease of the Kidneys; (4) Hæmorrhage; (5) Shock; (6) Cystitis; (7) Peritonitis; (8) Pyæmia.

(1) *Age* has a remarkable relation to the mortality after lithotomy. The lateral operation is rarely fatal in childhood; a dangerous operation, in middle life; and a perilous or fatal operation, in old age. This operation has been found to be four times as fatal in adults as in children, at the Norwich and Norfolk

Hospital. Cheselden lost only 1 patient out of 35 under ten years of age; and of the cases recorded by Mr South (in Chelius) as having been operated on at St Thomas's Hospital during a period of twenty-three years, the mortality, at that period of life, was only 1 in 58. Coulson's table of 2972 cases shows an increasing mortality at each successive decennial period:—under ten years, it is 1 in 13; it thence gradually rises, after ten to eighty years; to 1 in 9, 1 in 6, 1 in 5, 1 in 4, 1 in 3·65, 1 in 3·23, 1 in 2·71. The mortality at *all ages*, rates at 1 in 9, according to the St Thomas's table of 125 cases where the age was stated; but in 1827 cases, collected by Sir H. Thompson from the Metropolitan and Provincial Hospitals, the average mortality was higher,—nearly 1 in 8; and in Coulson's general table of 6505 cases, male and female, the average mortality rises still higher,—to 1 in 6·56, or about 2 in every 13 cases.

(2) *Size of the Stone*.—A large stone is far more dangerous than a small one, in regard to the result of operation; and the danger increases with the size, or *weight*, of the stone. This may be due either to bruising and laceration of the neck of the bladder, or to infiltration of urine and pelvic cellulitis; as the consequence of forcible extraction. Crosse's table of 704 cases, in the Norwich Hospital, shows the increasing danger according to the size of the calculus, estimated by its weight. When the weight of the stone was under 1 ounce, the deaths were in the proportion of 1 in 11·25 cases; from 1 to 2 ounces, 1 death in 6·61 cases; from 2 to 3 ounces, 1 in 2·18; from 3 to 4 ounces; 1 in 1·57;

and from 4 to 5 ounces, 1 in 1·66 cases. The chance—observes Mr. Coulson—which a patient has for recovery after lithotomy can, therefore, be calculated beforehand, and independent of every other consideration, from the ascertained dimensions or weight of the stone.

Out of 90 cases of death after lithotomy, collected by this author, by far the highest proportionate number—22, resulted from infiltration of urine, inducing pelvic cellulitis. Sir H. Thompson concurs in the frequency of pelvic cellulitis as the cause of death, but he would attribute it to bruising and laceration of the neck of the bladder, rather than to urinary infiltration; this opinion resting on the fact, that in children, the boundaries of the prostate are almost always overstepped by the knife, yet without giving rise to pelvic cellulitis.

(3) *Disease of the kidneys.*—Chronic pyelitis, or chronic nephritis resulting in degeneration of the kidneys with albuminous urine, may be said to represent that diseased condition of the kidneys which is most prejudicial to recovery after lithotomy.

In estimating the comparative mortality of lithotomy in *adults* and *children*, two elements seem to be in favour of the latter;—at an early period of life, the kidneys are usually sound; and the stone of small size,—thus entailing less liability to injury of the neck of the bladder, or to infiltration of urine followed by pelvic cellulitis.

In children, death generally results from some accidental violence; as the formation of a false-bladder in

the recto-vesical space, or disruption of the neck of the bladder from the membranous urethra. In adults, however skilfully the operation may have been performed, the state of the kidneys and the size of the stone may severally lead to a fatal issue. *Suppression of urine* may be mentioned as a rare cause of death, the kidneys being congested but not otherwise structurally diseased. Prof. Spence had one such case.

(4) *Hæmorrhage* is liable to occur primarily, or secondarily after the operation; in the latter case it takes place in about a week, or ten days, or even a fortnight. Primary hæmorrhage is rarely fatal; in Liston's experience, one such case happened in 100 operations; and Coulson has not experienced dangerous hæmorrhage frequently, although out of the 90 cases of death after lithotomy, which he collected, no less than 11 occurred from hæmorrhage,—primary or secondary; so also in France, Begin affirms that it is the cause of death in 1 out of every 4 deaths, and Boyer regards hæmorrhage as one of the chief dangers of lithotomy. (5) *Shock*, as the cause of death is very uncommon; and it generally happens in old people. (6) *Cystitis* is also an unusual cause of mortality; although Boyer attributes three-fourths of the deaths after lithotomy to this cause, or its consequences by extension to the kidney or peritoneum. (7) *Pelvic cellulitis*, as arising from infiltration of urine into the cellular texture around the neck of the bladder, would appear to be the inevitable consequence of a too free prostatic incision; yet this condition must be very rare, neither Sir W. Fergusson nor Mr Spence having met with it in

any post-mortem examination after lithotomy. The symptoms supervene in from twenty-four to forty-eight hours. (8) *Peritonitis*, as a consequence of cystitis or pelvic cellulitis, may thus prove fatal; but peritonitis *per se*, is a rare event, especially in adults. (9) *Pyæmia* is seldom consequent on peritonitis; but it more frequently arises from inflammation of the prostatic plexus of veins, and generally in old persons, at the end of a week or fortnight. In one case, pyæmic infection supervened as late as the fourth week, when the wound had nearly closed (Spence). Pyæmia seems to be a frequent cause of mortality, 10 deaths having thus occurred in the 90 cases referred to.

In estimating the results of lithotomy, no Surgeon should judge from his own experience of a *limited* number of successful cases, in succession. I, for instance, have not yet lost a case; and Surgeons of very extensive experience are well aware of the fallacy of these serial cases. It has been truly said that “ten, twenty, thirty cases may succeed without interruption, and the operator flatters himself he is never to lose a patient; when two or three deaths follow in quick succession, and reduce him to a level with his neighbours, or at least within the limits of variation which the analysis of a large number of cases indicates.”

RECURRENCE OF STONE.—After the lateral operation of lithotomy, and after the median operation also, a second stone sometimes forms. The liability to this recurrence of calculus, and its relation to various circumstances, have been statistically investigated by Mr C. Williams, of the Norfolk and Norwich Hospital,

From the opening of the Hospital in 1772 to November 1863, or during a period of ninety-one years, 923 cases of stone in the bladder underwent some form of lithotomy, excluding 2 cases of lithotrity; of these, 24 suffered a relapse, and underwent a second operation. The proportion of such cases to the whole number of stone-patients is 1 in 38·45. Of the 24 cases of recurrence, and a second operation of lithotomy; 19 were cured, and 5 died; 3 had stone a *third* time, 2 of which were cut and recovered, the third was deemed unfit for operation. All the patients were males, no instance having shown itself of recurrence in the female. In respect to *age*;—6 of the cases were under ten years of age; 2 between ten and twenty; 1 between twenty and thirty; 4 between thirty and forty; 2 between forty and fifty; 2 between fifty and sixty; and 7 between sixty and seventy. One death occurred below forty years of age; and four above that period of life. The *period* of recurrence varied from one year to twelve years; the average period was thirty-three months. *Lateral* lithotomy was performed in all the cases, excepting 8; 2 of which were cut on both occasions by the median operation, and in 4 this operation was resorted to on the second occasion. In 14, the calculi were removed in a perfect and entire condition at the first operation; while in 8, the calculi were broken in the extraction; in 1, the stones were very small and numerous; and in the remaining 1, a sacculated stone was left undetected in the bladder. The *nature* of the second calculus was not in all cases the same as that of the first; in 16, the second formation had the same

composition as the first, 9 of which were phosphatic, while 7 consisted of lithic acid and the lithates; the phosphates succeeded the lithates in 5, and the oxalates in 2 cases.

MEDIAN LITHOTOMY.—The median operation of lithotomy is so named, because the incision is made in the *middle line* of the perineum. But this operation comprises two methods of procedure in relation to the *prostate*; a vertical section of the membranous urethra alone, and then dilatation of the prostate with the neck of the bladder,—“*lithectasy*” in the male, as it might be termed; or a vertical section of the prostate, as well as of the membranous urethra. Formerly the one was called also the “*Marian operation*,” as having been advocated by Sanctus Marianus; and the “*operation of the apparatus major*,” from the number of instruments employed in performing it.

The Old Marian Operation.—A grooved staff was introduced into the bladder, and the patient trussed up as for lateral lithotomy; the operator then made a vertical and nearly central incision, just to the left of the *raphé*, and terminating just above the anus. The *membranous urethra* was opened in the groove of the staff, and the knife being kept well in the groove, a long probe was passed by the side of the knife into the bladder. Both staff and knife were then withdrawn, leaving only the probe as a guide to the bladder. Along this instrument two iron rods or “*conductors*” were introduced, and by separating their handles, the prostate and neck of the bladder were dilated,—or as John Bell observes, the operator “*tore open the*

prostate." The conductors were held aside, and "dilators" introduced to make way for the forceps, wherewith the stone was extracted. Thus, as Le Cat expressed it, the two principles of the Marian operation were; "small incision, much dilatation." Vacca revived the median operation, and practised also a vertical section of the *prostate*; thereby avoiding laceration of this part, but endangering the rectum.

Allarton's Operation.—The Marian operation had long fallen into disuse, but of late years it has been revived and slightly modified by Mr Allarton; and with his name Median lithotomy is now generally associated, in this country.

The operation is performed much in the same way as by the old Marian operation, up to the introduction of the probe into the bladder; when the *forefinger*, instead of dilators, is passed along the probe, and with a semi-rotary motion, the prostate is thus dilated. The points to be attended to are these:—the curved staff is held by an assistant, firmly, perpendicularly, and hooked up against the pubes; the forefinger of the left hand is introduced into the rectum, so that its point shall steady the staff in the prostate; a straight, sharp-pointed knife is entered into the perineum, in the *middle line*, about half an inch above the anus, and carried on steadily until it strikes the groove of the staff at the membranous urethra in front of the prostate,—a depth of about one inch and a half; the knife is moved along the groove towards the bladder for a few lines deeper, and then withdrawn, at the same time cutting upwards an external incision of $\frac{3}{4}$ to $1\frac{1}{2}$

inches, according to the presumed size of the stone. A long ball-pointed probe is slid along the groove of the staff into the bladder, and the latter instrument then withdrawn, as in the old Marian Operation. But the left forefinger is passed along the probe into the bladder, and used to dilate the prostate and neck, serving also as a guide to the forceps. When the stone is free, it comes at once into contact with the finger, and, if of moderate size, escapes readily into the wound on withdrawing the finger, the patient having power to strain upon and thereby facilitate the extraction of the stone.

The advantages claimed for the median, over the lateral operation, are ; that the incision being strictly in the median line, no vessels are divided, and no gaping open wound is left ; the integrity of the bladder being preserved, and no chloroform given, the patient himself helps to expel the stone. This operation is most suitable for *small* stones, and where lithotritry is inadmissible.

Yet the *results* of Median, as compared with those of Lateral Lithotomy have been generally unfavorable ; a difference owing doubtless to the fact, that in median lithotomy, *without* section of the prostate, this gland and the neck of the bladder are bruised and lacerated by the dilatation,—whether with “dilators” or the “forefinger.” Thus, comparing the results of 44 cases of median lithotomy with the last 44 current cases of lateral lithotomy in the Norwich Hospital, 1863 ; Mr Williams’s table shows that of the median cases, 11 died, whereas of the lateral cases, only 2 died. But,

per contra, of 23 cases of median lithotomy performed in Leeds, Mr Teale reports that 20 recovered, and only 3 died. Fifteen of the operations were in adults, with a proportion of 13 recoveries, and 2 deaths. The average period of recovery—in the former series—was seven days in favour of the median operation; thirty days instead of thirty-seven, as after the lateral operation. The weight or *size* of the calculus will much affect the result. There was no instance of recovery where the stone exceeded 3 drachms and 2 scruples,—except in one case of a stone weighing $4\frac{1}{2}$ ounces, but the extraction of which was followed by sloughing of the rectum and perineum, with recto-vesical fistula. Nor was there an instance of recovery when the stone exceeded $1\frac{1}{2}$ inch in its long diameter, and $1\frac{1}{8}$ inch in its short axis,—otherwise than the exceptional case just mentioned.

Rectangular Staff Operation.—Dr Buchanan of Glasgow introduced this procedure, which is a modification of the median operation. He used a rectangular staff, with the short branch grooved at its side. This instrument having been passed into the bladder; the angle is made to correspond in situation with the front of the prostate, the lower or grooved branch lying parallel to the rectum. The left forefinger is passed into the rectum, and a long straight knife, held with the blade horizontal and the edge turned to the left, is made to enter the perineum opposite the angle of the staff and passed straight into and along the groove, into the bladder. The membranous urethra is thus left *untouched*. In withdrawing the knife, a lateral

section of the prostate is made, in its left lobe; and at the same time, an external incision downwards and outwards, round the upper and left side of the anus, to about $1\frac{1}{4}$ inches in extent.

Certain features in this operation are adduced in its favour:—the more direct line to the prostate, which, at the angle of the staff, is situated close to the surface of the perineum; the membranous portion of the urethra is avoided; all blood-vessels are out of the way, and consequently there is no important hæmorrhage; the rectum is less liable to be wounded; and there is less risk of deep-seated infiltration of urine.

BILATERAL LITHOTOMY.—Dupuytren's operation consisted in making a semilunar incision, transversely, in front of the anus; the convexity of this incision being upwards, and the horns extending laterally to between the anus and the tuberosity of the ischium on either side. The tissues were carefully divided upwards to the membranous urethra, avoiding the rectum; this portion of the urethra was opened by a median incision from before backwards, with a double-edged bistoury; then, the curved double lithotome was passed along the groove of the staff into the bladder, the staff withdrawn, and the concavity of the lithotome being directed downwards, the blades were opened, and, in withdrawing the instrument, both sides of the prostate were divided obliquely downwards and outwards to the requisite extent. The extraction of the stone is then accomplished in the usual manner.

The principal advantage of this method is the facility it offers, by a free prostatic opening, for the extraction

of *large* calculi ; an advantage which can, however, be gained, when necessary, by bilateral section of the prostate, in the ordinary lateral operation. The risk of hæmorrhage is not less than in that method of operation ; and the bilateral section, dividing both seminal ducts, endangers the emasculation of the patient.

Bilateral lithotomy has been performed chiefly by French surgeons ;—Roux, Sanson, Blandin, and Velpeau ; and in America, by Professor Eve of Nashville University.

The results of this operation are unfavorable ; 19 deaths having occurred in 85 cases, or 1 in $4\frac{1}{2}$ cases.

Medio-bilateral Operation.—Civiale, in 1836, modified the median operation by his medio-bilateral procedure. It consisted of a median perineal incision, followed by a transverse section of the prostate with a straight double-bladed lithotome, which was passed into the bladder through the membranous urethra, along the groove of the staff, and the blades withdrawn open.

QUADRILATERAL SECTION OF THE PROSTATE has been recommended by Vidal de Cassis, in cases of *very large* stone ; no matter what the direction of external incision may be, so that it is not too small,—whether oblique, vertical, transverse, or curved. The principles of this operation are ; to have one large external incision, and many small internal ones. The two first sections of the prostate are made along the inferior oblique diameter of the gland on either side, which will prove sufficient when the stone is of moderate size ; but, two superior oblique sections must be added,

first one and then the other, when the stone is very large.

RECTO-VESICAL OPERATION.—Lithotomy through the rectum is claimed by Sanson as his procedure. A grooved curved-staff having been introduced into the bladder, a vertical incision is made, corresponding to the raphé of the perineum, and dividing the sphincter ani and lower part of the rectum. Continuing the dissection, the membranous portion of the urethra and prostate are exposed. A vertical section of the prostate is then effected; either by passing the knife along the groove of the staff from before backwards, or by entering the knife behind the prostate and drawing it forwards on the finger in the groove of the staff. A portion of the base of the bladder, uncovered by peritoneum behind the prostate, may even be divided. The staff is withdrawn, the finger introduced, and the stone extracted with the forceps. Recto-vesical lithotomy was practised in this country, by Mr Lloyd.

This operation has been recommended on the ground of its affording an easy passage for extracting instruments, and as being free from the risk of hæmorrhage. But there is a great risk of wounding the peritoneum and vesiculæ seminales; and of the subsequent occurrence of urinary infiltration, the passage of fæces into the bladder and recto-vesical fistula. Coulson has seen cases of permanent fistulous communication. This method of lithotomy has, therefore, been discarded; and it cannot be deemed advisable even in cases of impacted calculus in the wall of the bladder.

The *results* are very unfavorable; in 185 cases thus

operated on, 38 died, being a mortality of 1 in 4·86. And the subsequent condition of those who recovered is not stated. But the mortality varies according to the mode of operation; and adversely with regard to the method by incision extending *behind* the prostate. Thus, in 6 such cases by Dupuytren, 3 of the patients died from pelvic cellulitis. Then again, the risk of recto-vesical fistula depends on this incision; the 3 remaining cases of the 6, having had that result. Of 7 cases by Vacca, with division of the fundus of the bladder, 4 or 5 resulted in the same condition; and so also 3 out of 4 cases operated on by Geri.

SUPRA-PUBIC, HYPO-GASTRIC, OR HIGH OPERATION.—The *size* of the calculus, or the state of the *perineum*, especially with regard to the pelvic outlet, may render perineal lithotomy, in any form, impracticable. Under these circumstances, or other impracticable conditions, recourse may be had to supra-pubic lithotomy. In *children*, and persons below twenty years of age, the bladder stands high above the pubes, and presents a portion uncovered by peritoncum, which is freely accessible; under eight years, the peritoneal reflexion from the bladder does not generally reach lower than one inch and a half to two inches from the navel. In *old* persons, especially when emaciated, the bladder lies deep in the pelvis, behind the symphysis pubis, and would be difficult to reach; especially in a corpulent person. Chronic cystitis, resulting in a thickened state of the bladder, might also render the operation more difficult.

In order to perform supra-pubic lithotomy, the

bladder must be made to rise above the pubes ; and this may be accomplished either by full distension of the bladder with water, or by means of a catheter or other instrument introduced through the urethra into the bladder, so that its point shall project above the pubes. Both means are adopted to ensure a presenting part or point of the bladder in that situation. The operation consists in making a vertical incision in the middle line, above the pubes, carried upwards to about three inches in length ; the linea alba is exposed, and the incision carried through the muscular wall of the abdomen and fascia transversalis ; the projecting part of the bladder, uncovered by peritoneum, is sought just above the symphysis, and opened on the point of the instrument within its cavity ; this incision being prolonged downwards towards the neck of the bladder with a probe-pointed bistoury, sufficiently to admit the finger. The forceps is then passed in, and the stone extracted. Accidental fracture of the calculus will present a difficulty of more consequence than when it occurs in the lateral operation ; for the bladder cannot readily be washed out, and a fragment remaining, the recurrence of stone is inevitable. Various instruments have been devised wherewith to puncture the bladder from within, when reached by the incision. Thus, the *sonde-à-darde* is a puncturing instrument, combining a trocar concealed in a catheter ; and this was used by Civiale. The performance of this operation is much more difficult than it would appear to be.

The *after-treatment* is simple ; urinary infiltration is prevented by placing the patient on his back, and it

may perhaps be advisable to introduce a gum-elastic catheter into the bladder, leaving it there for a few days until union of the wound has taken place. Formerly, it was thought necessary to close the bladder by sutures; and even to make a counter-opening through the perineum into the membranous urethra or the neck of the bladder, with a view of securing a free drain for the urine. These complications are now entirely discarded, whenever the operation is occasionally resorted to.

The *results* of this operation are, however, singularly fatal. Professor Humphry, of Cambridge, has shown that in 104 cases, 31 were fatal, mostly in consequence of peritonitis and urinary infiltration; a mortality of 1 in 3·08. He had himself 1 successful case, and other Surgeons, especially M. Souberbielle, Sir Everard Home, Carpue, Kirby of Dublin, and Dr Carpenter of Pennsylvania, have also had occasionally a successful result. But it should be remembered, that the operation is had recourse to when the stone is of unusually large size, coupled with a narrow pubic arch; so that the lateral operation being inapplicable, the results of the two methods cannot fairly be compared.

LITHOTRITY.—The operation of breaking-down the stone in the bladder, so as to allow of its extraction, or discharge, by fragments through the urethra, was early devised and attempted, in some way, as a substitute for the cutting operation of lithotomy. This procedure was noticed by Hippocrates amongst the Greeks; by Albucasis of the Arabian school; by Franco, Guido de Cauliaco, Hildanus, Haller, and

other authors down to the end of the last century. In 1813, Gruithuisen, a Bavarian Surgeon, published two memoirs on the subject; describing his instruments for the drilling or *boring*, and then crushing the fragments, of stone in the bladder. But these isolated and imperfect attempts failed to introduce Lithotrity into the Practice of Surgery. Civiale, in 1817, then a poor student, first succeeded in drawing attention to Lithotrity, by constructing certain boring instruments, which he brought before the notice of the French Minister; and continuing his labours in subsequent years, followed by Elderton in 1819 ('Edin. Med. and Surg. Journ.'), by Amussat in 1822, and Leroy d'Etiolles in 1823, this method of removing stone from the bladder acquired a recognised and established reputation.

The first operation of lithotrity in the living subject was performed by M. Civiale, January 13th, 1824. Subsequently, in this country, the first *crushing* instrument of any value, was invented by Mr Weiss, in 1824. It consisted of two blades, sliding one within the other, and worked by a screw at the handle. With a somewhat similar instrument, in 1825, Mr Hodgson at the Birmingham Hospital, first performed the operation of crushing stone in the bladder. Baron Heurteloup in 1830, and Costello afterwards, devised an instrument for *hammering* the stone to pieces; but the crushing procedure prevailed, and was mainly brought into practice by Sir B. Brodie. It is also worthy of record, that the oval slit in the under or female blade for the escape of detritus, in using the lithotrite, was suggested

by Mr Oldham, a gentleman connected with the Bank of England. Since the period referred to, lithotritry has received the special attention of Coulson, Skey, and Sir H. Thompson. The latter Surgeon has presented the results of his experience in "An Analysis of 184 Consecutive Cases of Stone in the Bladder of the Adult, treated by Lithotritry." ('Med. Chir. Trans.,' 1870.)

The *lithotrite*, or instrument for crushing the stone, now in general use is Weiss's "newly invented Lithotrite," or Sir Henry Thompson's lithotrite (Fig. 22). It enables the operator to exercise powerful, yet nicely regulated screw-pressure; its cylindrical and finely fluted handle aids the sense of touch; and the whole is a light and delicate instrument. Another form of instrument is

FIG. 22.



also used by Sir William Fergusson,—a rack and key lithotrite, but which is I believe seldom employed. I prefer a screw instrument, and especially Thompson's

FIG. 23.



FIG. 24.



lithotrite, for the three reasons just stated. The fenestrum or oval aperture in the under blade (Fig. 23) is of

great importance, as already stated ; but Civiale's lithotrite (Fig. 24), having no aperture in the female blade, is suitable for crushing fragments of stone. A steel sound, for detecting fragments, is also very serviceable ; and an injecting apparatus will be required, consisting of large-eyed catheters of different sizes, and a strong, large-sized brass syringe, the nozzle of which fits the catheters.

Preparation of the Patient for Lithotrity.—Prior to any operation for breaking-up a stone in the bladder, it is absolutely necessary that not only should the general health be attended to, but that the bladder more especially should be brought into as quiet a condition as possible. Freedom from vesical irritability or inflammation is more important in relation to lithotrity than to lithotomy ; the former operation being perhaps an unavoidably more prolonged procedure within the bladder, a repeated operation, and one which leaves fragments of stone behind as a continued source of irritation during their discharge. Hence, if the bladder or kidneys be diseased, lithotrity should be postponed or abandoned.

Lithotrity is thus performed :—The patient having been placed recumbent on a bed or couch of convenient height ; the pelvis should be slightly raised on an unyielding pillow so as to bring the lower fundus of the bladder in a line with the urethral orifice ; the head and shoulders should be supported by pillows, and the legs separated and somewhat flexed. Chloroform may, or may not, be administered. Civiale and Sir B. Brodie were both averse to its anæsthetic influence, alleging that the feelings of the patient are a safe guide in two

essential matters ; as to whether any injury is being inflicted on the bladder, and whether the operative proceeding is continued beyond what the bladder and constitution are capable of enduring. But, assuming a due manipulative skill in using the lithotrite ; the irritable state of the bladder, and a nervous, restless state of the patient, in many cases, will as often render the influence of chloroform an invaluable or indispensable adjunct in performing lithotrity. The bladder is first emptied, and then injected with tepid water until it contains about five to seven ounces of fluid ; in order that its cavity shall be sufficiently distended to remove the mucous membrane from the blades of the lithotrite in seeking the stone, and to make room for crushing without injuring the bladder by splintering. In old cases of stone, the bladder may be so thickened and irritable as to eject a few spoonfuls of fluid ; then the injection must be repeated very slowly, and gradually, pausing occasionally until the bladder becomes accustomed to the increasing distension. Civiale, Sir B. Brodie, Coulson, and other lithotritists approve of injecting the bladder ; while, Sir H. Thompson and other Surgeons of large experience, dispense with injection, as being an unnecessary or prejudicial addition of instrumental interference, and therefore allow the urine to be retained. But on no account without sufficient dilatation of the bladder should the operation be proceeded with. Then, the Surgeon, standing on the right side of the patient, as the most convenient position, introduces the warmed and oiled lithotrite cautiously, along the urethra. The

abrupt curve of this instrument, unlike the arched curve of the catheter, and resembling that of a sound, must be remembered as soon as the instrument reaches the curved portion of the urethra. By depressing the handle slowly down to a right angle with the perineum, the end of the lithotrite is brought into the direction of the canal under the pubic arch, and thence passed gently into the bladder. A slight rotatory movement with the instrument will always indicate when it has entered the bladder.

Seizure of the stone may be effected in either of two ways; by making it *fall* into the blades of the lithotrite, or by *searching* for it in a certain manner.

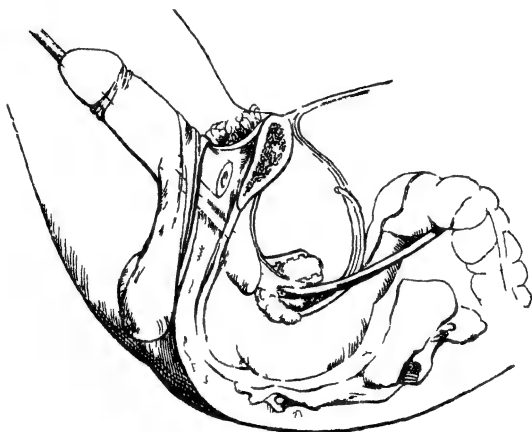
Sir B. Brodie recommends that the instrument should be raised, the blades opened, and that the convex extremity of the under or female blade should be rested against the lower fundus of the bladder, and gently pressed down, so as to make a conical *depression* in this situation; into which the stone falls by its own weight, or by a slight shake or jerk of the instrument with the hand. Similarly, Mr Skey gives a smart blow with the open hand against the pelvis of the patient, a *coup*, he says, which will succeed again and again in making the stone fall into the grasp of the lithotrite. The male branch is pushed forwards to seize the stone. This manœuvre may have to be repeated several times before the stone is securely caught; the female branch remaining stationary, while the male branch is slid a little up and down alternately, until the stone is seized. Civiale recommends another method, in principle, as Sir H. Thompson observes, the reverse of the preced-

ing. By position of the patient, the centre of the bladder and space beneath it are selected as the area of operation ; *no depression* is made ; contact between the walls of the bladder and the instrument is, as much as possible, avoided. The instrument is applied to the stone in the situation which it naturally takes, and the operator carefully avoids moving it, or any movements of concussion whatever, however slight.

The *situation* of the stone is often ascertained in *passing* the lithotrite ; then, the blades are inclined slightly away from the side on which the stone lies, carrying the instrument backwards also towards the posterior wall of the bladder, while the male blade is slowly withdrawn, not to impinge on the neck of the bladder. Turning the opened lithotrite over towards the stone, and slowly closing the blades, the stone will almost certainly be seized (Fig. 25). Most frequently the stone will be caught on the right side of the floor of the bladder. If no stone be felt on entering the bladder, its cavity is *explored* ; first, without altering the axis of the shaft of the instrument from its central or vertical position, by simply inclining the open blades to the right side, and then to the left side ; finding no stone ; secondly, depress the handle of the instrument about half an inch, thereby raising the open blades slightly from the floor of the pelvis to a horizontal plane, and turn them to the right and left. In completing each of these movements, the blades are closed to seize the stone. These five positions—vertical, right and left incline, right and left horizontal, will explore the bladder fully—middle, right and left, and will thus

almost certainly find any stone of moderate size in a healthy bladder. If the prostate be enlarged, and the

FIG. 25.



(Liston.)

stone possibly lodged in a depression behind it; or if the stone be small, or a fragment only, the blades may be reversed or turned downwards, and the handle raised, when it will often be found and secured with ease.

To meet the difficulty of *prostatic* enlargement, a modified form of lithotrite may prove serviceable; the curve of the instrument is made shorter and more abrupt, so as to mount over the projection of the prostate, especially if the middle lobe be enlarged, and the shaft is longer by two or three inches, on account of the elongation of the urethra; this twofold construction of the instrument corresponding to that of the prostatic catheter. It will be desirable also to elevate the

pelvis, so that the stone shall fall back towards the posterior wall of the bladder; and thus further aid the manipulation of seizure.

The object of Civiale's method is strictly to avoid giving any jerk to the instrument or to the bladder; and by barely coming in *contact* with its interior, no pain or contraction of the bladder is provoked. The same object was sought to be attained by the other method, simply by *not moving* the instrument in the bladder for the purpose of exploring to ascertain the situation of the stone; the instrument, being rested, and somewhat depressed, in the lower fundus of the bladder, to make the stone fall into its blades.

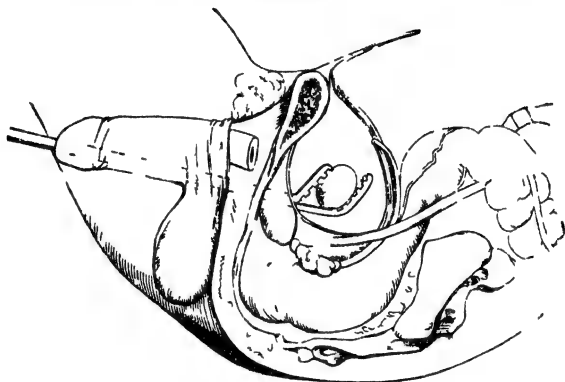
Coulson seems to combine *both* these methods in using the lithotrite; a slow twirling revolution of the instrument on its own axis between the thumb and finger, without changing its central direction; and at the same time, a gentle sliding motion of the male branch backwards and forwards to the extent of half or three quarters of an inch—thus gently raking or traversing the floor of the bladder on either side successively.

Of these three methods of using the lithotrite, I prefer the latter.

Crushing the Stone.—When once firmly fixed between the blades of the lithotrite, the stone is to be crushed into fragments. It is raised to the centre of the bladder, so that the mucous membrane shall not be injured by the splintering of the stone (Fig. 26). Crushing may first be attempted by pressure with the *hand* alone, without the action of the screw. The *old* screw lithotrite is adapted for this double action. The

female branch is held firmly by the left hand, applied to the square portion; the circular projection immediately behind is embraced between the index and

FIG. 26.



(*Laston*)

middle fingers of the right hand, hooked on to it and used as a point of resistance; the expanded extremity or wheel of the male branch rests in the palm of the same hand turned upwards and forwards. In this position, by strongly and repeatedly contracting the fingers towards the palm, the male branch is slowly and cautiously driven forwards on the stone, which is distinctly felt to break down. A small stone may thus be easily crushed. When this manipulation fails, the *screw* must be brought into action. Still holding the female branch firmly with the left hand, the handle of the screw is held between the thumb and fingers of the right hand, and the screw worked gradually from left to right; thus propelling the male branch forwards on the stone. Thompson's (screw) lithotrite is readily used,

the fingers and thumb of the left hand holding the round fluted portion, while the wheel is turned with the right hand, applied in like manner. The sliding motion of the male blade of the instrument is checked by the action of a metallic button in a groove on the upper surface of the fluted cylinder.

In either mode of crushing, by hand-pressure or screw-pressure, the male branch must be sent home into the female branch, so that the blades come together. This object is known to be attained by observing that the entire length of the screw passes down the lithotrite. Then the instrument can be safely withdrawn.

The fragments must be got out of the bladder as soon as possible, but not by a prolonged use of the instrument; lest in removing one source of irritation and inflammation, another be substituted. The crushing should not be repeated, unless the stone is small and friable and can easily be reduced at once. This first sitting should be short, not exceeding five minutes.

Detritus can be removed amounting to a considerable quantity, and containing some not insignificant fragments. For this purpose, the bladder should be washed out with tepid water, injected through a large-sized and large-eyed, double-current catheter. Clover's lithotritic injection-apparatus consists of a series of such catheters, with an india-rubber bottle, the nozzle of which fits the opening in the stem of the instrument. By repeating the injection three or four times, the fluid drawn off at last ceases to contain any detritus. This was Civiale's practice. Sir H. Thompson, usually, does not wash out the bladder.

After-treatment.—The patient should lie in bed, recumbent, for twenty-four hours, and not be allowed to stand or stoop forward in passing water, lest fragments might fall against or lodge on the neck of the bladder, greatly increasing the risk of irritation. Diluent drinks will promote the discharge of the detritus. In elderly persons with enlarged prostate, the discharge of fragments is impeded, and Sir B. Brodie recommends that the bladder should be washed out daily.

Subsequent sittings will be required to crush the fragments. Intervals of from three days to a week should elapse; when the operation may perhaps be prolonged to ten minutes at a time, as the bladder becomes accustomed to the instrument, or its irritability subsides with the gradual removal of the calculus. Generally from three to six sittings must be allowed, before all the fragments can be safely crushed.

In performing these after-crushings, Civiale's lithotrite with no slit in the female blade, is very serviceable for breaking-down and removing fragments; the instrument being withdrawn charged with more than detritus. Fragments of rather large size may thus be extracted safely through the urethra. Having seized a fragment, the size of which may be estimated by observing the separation of the blades as indicated by the length of screw exposed at the handle of the instrument, the fragment is drawn to the neck of the bladder; when by a sort of slight pulling jerk with the instrument, the practicability of easily extracting it through the urethra can be ascertained. The bladder

is washed out, to remove smaller particles. This procedure of fragment-extraction I have seen practised by Sir W. Fergusson. It is generally preferable, however, to crush all fragments, and allow the powdered *detritus* only to escape per urethram ; according to the method of Sir H. Thompson.

A *final* exploration of the bladder is made to determine the complete removal of every fragment ; any one remaining portion would form the nucleus of another calculus. 'Civiale's method of exploration consists in sounding the bladder, with the patient recumbent, and while the urine or tepid water injection is flowing away, thus to excite the contractile action of the bladder, in order to bring any fragment more readily within reach of the instrument. This procedure having failed, a small lithoclast is introduced, and rotated slowly in the bladder, while the injection passes out through the central channel of the instrument, the blades being opened to catch the fragment. Unless there be an encysted bladder, or an enlarged prostate, such exploration usually proves successful. The persistence of symptoms would, however, indicate the continued presence of some portion of the stone.

Certain *Difficulties* are liable to occur in the performance of lithotrity. They may be sufficiently anticipated and overcome by due attention to the directions given respecting the operation. Excessive Sensibility and Irritability of the bladder, Enlargement of the Prostate, and the Impaction of angular fragments of stone in the Urethra ; may thus severally be managed. But the latter difficulty is noticed, more particularly, under

Calculus in the Urethra. Encysted Calculus,—a stone lodged in a sacculus of the bladder, presents a specially difficult complication in lithotritry,—no less than in lithotomy,—with regard to seizure of the stone; but, in the former operation, the after-treatment may also be rendered difficult by the impaction of a fragment in the sacculus, a condition which led to a fatal result in a case treated by Sir B. Brodie.

The Dangers of Lithotritry are referable to the state of the bladder and kidneys, induced by the operation.

Hæmorrhage happens, sometimes, to an inconvenient amount for the free working of the instrument; though rarely to a dangerous extent. In the 115 cases operated on by Sir B. Brodie, he did not meet a single example of serious loss of blood from the urinary organs. It was, however, so copious as to necessitate immediate recourse to lithotomy, in a case operated on by Mr Key; and a patient at the Hôtel Dieu, in 1832, died of hæmorrhage from the bladder.

Cystitis, acute, or more frequently chronic, ensues in some cases. This is usually the consequence of rough or prolonged lithotritry; although it may arise from pre-existing prostatic or vesical disease, or from the retention of a fragment. The latter causative condition is sometimes associated with an enlarged prostate, behind which the fragment lodges; but the want of expulsion commonly depends on an atonic state of the bladder. Hence, the injection of tepid water, slowly, to wash out any débris, will be appropriate, in aid of the treatment for cystitis. In 184 cases of lithotritry

by Sir H. Thompson, with 12 deaths, 3 died of cystitis or pyelitis.

Nephritis, acute or chronic, of one or both kidneys, is not unfrequently a consequence of the operation, and the cause of death. In the 12 deaths just referred to, no less than 7 resulted from this cause.

Atony of the Bladder, occurs chiefly in old persons. The patient enjoys too quiet a state of the bladder after operation, the urine being retained with ease for several hours, owing to the loss of expulsive power. Chronic cystitis is very apt to supervene from retention of urine, in this deceitfully tolerant state of the bladder.

Spasmodic retention of urine sometimes follows the operation, and it occurs mostly in combination with an atonic state of the bladder. Both are most frequent in old persons, with enlargement of the prostate. The treatment of the spasmodic retention consists in giving a warm bath and then a full dose of opium. In either case, the urine must be drawn off with a large-sized catheter, rather than allow any accumulation in the bladder.

Retention from the impaction of coagula or a fragment in the neck of the bladder must be treated by catheterism.

Suppression of Urine, with coma, is an occasional consequence of the operation, and probably depends on some previously existing latent disease of the kidneys.

The *constitutional disturbances* incident to lithotrixy

may be comprised under rigors, and febrile attacks, including pyæmic infection. *Rigors* not unfrequently set in immediately after the operation, especially after the first sitting; and last perhaps for some hours, terminating in perspiration. This attack is most common and severe when the operation has been prolonged, or the urethra overstretched, and not at all in proportion to the amount of pain. A full dose of opium, or a tumbler of warm brandy-and-water, as Sir B. Brodie recommended, are the best remedies; the patient lying in bed and wrapped in a blanket. Irritative *fever* may ensue, which rapidly assumes a typhoid character; the pulse rising in frequency to beyond what can be distinctly counted, and becoming proportionately feeble and irregular, with a dry hot skin, and dry, harsh, brown tongue. This attack is more surely fatal than the most severe rigors. *Pyæmia* occasionally supervenes, probably in connection with suppuration as the result of damage done to the bladder. Of the 12 deaths in Sir H. Thompson's series of cases, 2 only were due to pyæmia. Pre-existing disease of the kidneys attended with albuminous urine, always tends to induce these unfavorable or fatal constitutional consequences of lithotrity.

Their treatment mainly comprises the administration of opium and stimulants, with tonics, especially quinine, judiciously regulated.

Lithotrity in Children is attended with certain *difficulties*, which as objections to this mode of operation at an early period of life, should not be overlooked. The small size of the urethra, and irritability of the bladder,

are unfavorable to the free working of the lithotrite ; while the dilatibility of the neck of the bladder allows of the impaction of fragments, even of some size. Small, and soft stones are most suitable for the operation ; and it has been practised, occasionally, and with success, by Civiale, and other surgeons, both in male, and female children. But the great success of lithotomy, in young subjects, has brought this operation in to a far more established repute.

Results of Lithotrity, and, as compared with Lithotomy.—Unquestionably the accumulating results of experience in lithotrity lead to the conclusion that a far larger proportion of cases can fairly be submitted to this method of treatment than was formerly supposed, instead of to lithotomy. When first practised in this country, the results of Sir B. Brodie's 115 cases showed a mortality of somewhat less than 1 in $12\frac{1}{2}$; whereas the mortality of lithotomy is about 1 in 7, or even as high as 1 in $4\frac{1}{2}$. Civiale's cases of lithotrity in one year—1862, amounted to 45, about his annual average. Of these, 8 were partially cured ; and the operation was successful in all the remaining 37, but 1. The same distinguished lithotritist states that his total mortality in 591 operations, was 14 deaths, or only 1 in 42.21. But this general result has been much criticized. Sir H. Thompson has been very successful ; and his cases having been more clearly recorded (Med. Chir. Trans. 1870), they afford trustworthy evidence of the mortality. From an Analysis of 184 consecutive cases of lithotrity in the adult ; it appears that the deaths, reckoning every kind of casualty following the

operation, were 12, showing the recoveries to be 93 per cent. ; but, omitting 5 cases of death from previous disease of the bladder or kidneys, and thus leaving 7 deaths from operation ; the recoveries amounted to 96 per cent., and the mortality to only 4 per cent. Mr Crichton has performed lithotrity in 122 cases with only 8 deaths, or less than 1 in 15. Sir W. Ferguson's experience extends to 271 cases of stone, of which number 217 were in adults ; 110 were submitted to lithotomy, with a mortality of 33 ; whereas of 109 treated by lithotrity, only 12 died. These results are more valuable than those of Sir H. Thompson, who has published *only* his series of lithotrity cases ; thus withholding the requisite *data* for a comparative estimate of the two operations, and as performed by the same operator. Mr Charles Hawkins has collected the results of all the cases of stone in the bladder admitted into the London Hospitals (excepting the Hospital for Stone), in the years 1862-63. The total number of patients was 177, comprising 86 children and 91 adults ; of the whole number it would appear that only 32 were treated by lithotrity, while 139 underwent lithotomy—the remaining 6 cases not having been submitted to either operation. Considering the relative mortality of the two operations—so highly in favour of lithotrity ; the small proportion of cases submitted to this operation would scarcely seem judicious. At the Royal Free Hospital, it is true, the 7 cases of stone in the two years, all underwent lithotomy ; but then they were all cases in children.

SELECTION OF OPERATION.—LITHOTOMY OR LITHOTRITY.

—The practical importance of a judicious selection of cases for either operation is well enforced by Civiale's statistical results, in regard to all the calculous patients on whom he operated, in one way or the other, during a period of twenty years. The total number being 838 cases of stone in the bladder; only 548 were fit cases for lithotrity, 290, or more than one third, were not operated on by this method; and of the last 332 cases included in this list, 241 were lithotritized, leaving 91 which were considered unfit for that operation. Of the 91 cases; 28 were lithotomized, and in 8 others the two operations were combined, making a total of 36 cases subjected to lithotomy; and of which, Civiale lost 18, or exactly one half.

The *conditions* which determine the fitness or applicability of lithotrity, are:—(1) The state of the urinary organs, and of the bladder and kidneys in particular; (2) the general health of the patient, and as connected with age; (3) the nature of the calculus—as to size, density, shape, situation, and number.

When the bladder is healthy, and the kindeys free from disease, especially with regard to albuminous urine; the general health not deteriorated; and the stone small, and friable; all the conditions concur in favour of lithotrity. The opposite conditions are, of course, unfavorable in a greater or less degree.

(1) The conditions of the *urinary organs* relate to the bladder, kidneys, prostate, and urethra. As more or less unfavorable may be mentioned; an irritable or inflammatory state of the *bladder*, or an atonic state, or an hypertrophied bladder of diminished capacity. The

latter state is not unfrequently associated with extreme irritability of the bladder, thus further contracting its cavity. Chronic cystitis and especially of a purulent character, is a more unfavorable condition for operation, than acute cystitis; which is also comparatively rare. But the significance of cystitis in relation to lithotritry, depends very much upon whether the former be the cause or the effect of calculous formation. A stone consequent on cystitis is usually phosphatic, and being therefore soft and friable, it yields readily to the lithotrite. Disease of the *kidneys* of a nephritic or degenerative character, attended with morbid states of the urine, are specially unfavorable. Hence, casts of the tubes or blood in the urine, and the appearance of albumen to any amount, as persistent albuminuria, contra-indicate the performance of lithotritry. Enlargement of the *prostate* is in *itself* only a mechanical objection to the operation; the stone often being lodged in a depression behind the enlarged gland, and not easily accessible to the lithotrite. Enlargement of the middle lobe more especially, diminishes the capacity of the bladder, deepens its floor, and tends to conceal the stone in a cavity behind the gland. But an enlarged state of the prostate is often associated with an unhealthy state of the bladder, and occurs mostly in advanced life. Tumours in the bladder may offer considerable mechanical difficulty to lithotritry; but according to Civiale's experience, the operation will be justifiable, when the tumour is small, not very sensitive, nor liable to bleed, and the stone is small and friable, so that the completion of lithotritry is not likely to be

prolonged by an unusual number of sittings. Stricture of the *urethra*, or an irritable state of the passage, will obstruct the introduction of the lithotrite, and retard the discharge of detritus.

(2) The conditions of the *general health* which are unfavorable for lithotrity, cannot be clearly defined; they comprise chiefly a deranged state of the digestive organs, with loss of flesh and strength; nervous depression; and recurring febrile attacks. But, in the 184 cases operated on by Sir H. Thompson, "many" of the patients were of "very feeble health and constitution."

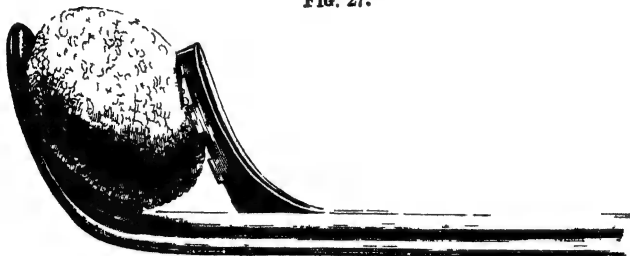
Age is significant in its relation to the accompanying state of the bladder and the health of the patient. In *children*, the diameter of the *urethra* is small; the antero-posterior diameter of the bladder is short; the organ is irritable, and its neck is very dilatable, a peculiarity which favours the impaction of the fragments; while the indocility of the child is a great difficulty in performing lithotrity, especially when repeated sittings are necessary. This latter difficulty can be overcome by chloroform; but the undeveloped condition of the genito-urinary organs before the age of puberty, renders the operation neither an easy nor a safe one. On the other hand, lithotomy is singularly successful. Nevertheless, if lithotrity diminishes the mortality in adults, it should, as Mr Coulson observes, have a still greater influence in reducing the comparative mortality when applied to children; in whom the urinary organs are in a healthy condition, and because the number of deaths in adults, after crushing the stone, is greatly increased by the state of the urinary

organs at that period of life. Sir W. Fergusson, Mr Curling, and other Surgeons in the London Hospitals, have performed lithotritry in children, and with not unfavorable results. In *advanced periods of life* and old age, the irritable state of the genito-urinary organs forbids lithotritry. Exceptional cases of successful results have been met with; Segalas having lithotritized 14 octogenarians, without losing one; and 97 septuagenarians, with the loss of only two. Of Sir H. Thompson's 184 cases; the mean age was no less than sixty-one years; forty-six were seventy years, and upwards; the oldest was eighty-four years; whereas, only three were below thirty years, and the youngest was twenty-two years old. Lithotomy, on the other hand, is very fatal in aged persons, although very successful in children.

(3) The *calculus* itself has an important influence with relation to lithotritry, more than to lithotomy. A *large* stone is unfavorable for crushing, owing to the number of fragments in the bladder and the continued discharge of detritus through the urethra, and the necessity for a more repeated performance of the operation. The bladder should be proportionately healthy, a condition not often co-existing with a large stone. From Sir H. Thompson's large experience, it appears that a stone about the size of a *date* or *small chestnut* (Fig. 27), and corresponding to somewhat less than an *ounce* in weight, is always suitable for lithotritry; all stones of an ounce weight, and upward, being reserved for lithotomy. A stone of this size, and weight, may be easily discovered by sounding. In

Sir H. Thompson's practice, lithotripsy has never proved fatal, when the stone was no larger than a small nut; but, the rate of mortality rises with the increasing size of the stone, above that of a small chestnut. A *hard*

FIG. 27.



stone yields sharp, angular fragments, very irritating to the bladder. A large and also hard stone may be said to contr-indicate lithotripsy. But a soft or friable stone, even of large size, is not an unfavorable kind of calculus. Hence, the chemical nature of the calculus has some relation to lithotripsy; certain uric acid calculi which ring when struck with the sound, and oxalate of lime or mulberry calculus, are not readily crushed; whereas phosphatic calculi are easily broken down. The different consistence of the two latter kinds of calculi, in their relation to lithotripsy, is, however, a consideration more than counterbalanced by the state of the urinary organs; in the oxalic acid diathesis, these organs being comparatively healthy; in regard to phosphatic calculi, equally unhealthy.

The remaining peculiarities connected with stone in the bladder, present mechanical difficulties chiefly, as

relating to the selection of the operation,—lithotritry or lithotomy. Thus, the *irregular shape* of a stone offers a difficulty in seizing it with the lithotrite. But similar difficulty is experienced in seizing with the lithotomy-forceps, and there is the additional difficulty of extraction. The *situation* of a stone may render it inaccessible; as when lodged in a pit behind an enlarged prostate, above the pubes, or encysted anywhere in the walls of the bladder. It may then be almost equally hard to get at in either operation. A *single* stone is more suited than several calculi to the performance of lithotritry, and of lithotomy also. But the time necessary for the operative procedure of crushing must be taken into account. The presence of several calculi is not unfavorable for the operation of lithotritry, provided only they be small and soft. Civiale operated with success in a case where the bladder contained 40 calculi.

The *chemical composition* of calculi submitted to lithotritry, has varied; all kinds of calculi having been crushed, but perhaps, chiefly those of uric acid and the urates. Thus, of Sir H. Thompson's cases; 122 were uric acid, and the urates; 16 were mixed; 40 phosphatic; 4 oxalate of lime; 1 pure phosphate of lime; and 1 cystic oxide.

Lithotomy after lithotritry is a procedure which admits of consideration as a justifiable resource, under certain exceptional circumstances. The propriety of submitting a patient to the double risk of two operations, either of which may be of serious consequence, and which are performed almost in succession, can be

sanctioned only by two orders of facts; that the one operation,—lithotritry, has given rise to symptoms which render it apparently impossible to complete this procedure, by repeated sittings, without perilling the patient's life; and, that the other operation,—lithotomy, offers the only means of relief, and with less comparative danger. The unfavorable symptoms may relate to the bladder,—the supervention of excessive irritability, or contraction, forbidding a second use of the lithotrite, especially if in addition, the stone is of large size and hard consistence, which would necessitate an unusual number of sittings; or, constitutional symptoms of a dangerous character may have been induced, the use of the lithotrite having provoked some pre-existing organic disease, particularly of the kidney. In either case, lithotritry should not be continued, and recourse may be had to lithotomy with advantage.

The *results* of lithotomy as a resource after lithotritry, have on the whole been encouraging. Of 28 cases by Civiale, 19 recovered, and 9 died. Of 12 cases by Souberbielle, 10 recovered; the remaining 2 deaths showing a mortality of 1 in 6, or not higher than the average death-rate of certain series of lithotomy cases, without previous lithotritry. But a more extended experience might not confirm this satisfactory estimate.

RECURRENCE OF STONE.—After lithotritry, a recurrence of calculus in the bladder is far more frequent than after lithotomy. In Civiale's practice, this has happened about once in every ten cases. Of 36 patients on whom he performed lithotritry in 1860; 10 had been previously operated on, and stone had returned. But

of Sir H. Thompson's 184 cases, a second operation for recurrence, was performed in only 13 cases. In no instance, however, was an operation of lithotrity completed by lithotomy.

Recurrence must arise from some fragment having remained in the bladder, which formed the nucleus of another calculus. Hence, the practical importance of carefully searching the bladder at the last; the final exploration or sounding, to which I have already alluded. If a small fragment can escape detection in such practised hands as Civiale's, less experienced lithotritists should be far more guarded in completing a case.

Irritability of the bladder, remaining for a long time, is a not uncommon sequel of lithotrity; itself successful. This never occurs after lithotomy; the bladder having been relieved of the stone, as the source of irritation, recovers its tone completely.

Treatment.—Whether after lithotrity or lithotomy, a secondary calculus must be removed. Which kind of operation should be repeated,—crushing or extraction, must be determined by the conditions already mentioned with regard to the selection of these operative procedures. Secondary lithotomy may be performed through the track of the former wound; care being taken to avoid the rectum, which is somewhat drawn up and adherent to the membranous urethra and prostate. A condensed state of the textures might be supposed to have taken place, and thus present some obstacle to their division, and to the extraction of the stone. But, in a case operated on by Professor

Spence, after an interval of fifteen years from the first operation by another surgeon, the patient was then almost sixty years of age, and had apparently a very deep perineum; yet the left side had become more shallow, the textures being atrophied, and the prostate yielded readily to incision and dilatation with the finger,—unlike the rigidity met with in age, so that the whole operation was easier of execution than usual. Lithotomy has been performed a third time, in the same patient, and with success. Right lateral lithotomy might be preferred, as Liston suggested, provided the Surgeon be ambi-dextrous. Or the median operation offers an available resource in these cases, the stone probably being of small size.

PROSTATIC, and URETHRAL, CALCULI, are more conveniently noticed in connection with Diseases of the Prostate Gland, and of the Urethra.

CALCULUS IN THE FEMALE.—Stone in the bladder is not of common occurrence in women, though not very rare. In 146 cases of stone operated on at St. Thomas's Hospital, during a period of twenty-three years; South states that 144 were males, and only 2 females, giving a proportion of 1 female to 72 males. This is greatly below the average. Crosse, at the Norwich Hospital found the proportion to be 1 female to 19 males. In France the average was higher; 1 to 22. But in Italy, Civiale finds the average to be 1 to 18; which may probably be taken to represent the general average. Coulson puts the proportion, among those who are submitted to operation, at about 1 female to 20 males. The probability is that stone forms more frequently,

than it is found, in the female bladder. This seems owing to the peculiar anatomical conditions of the urethra, which facilitate the escape of a small calculus. The urethra is short, almost straight, of large size and readily dilatable, without any natural contractions in the canal ; and there is no prostate gland at the neck of the bladder. Thence, a stone may form in the bladder, but more easily escape through the urethra.

In addition to the usual symptoms of stone in the male bladder, and the sure sign afforded by sounding ; two *special* symptoms occur in the female. These are, bearing-down pains and pains along the urethra, and incontinence of urine,—a tendency to constant dribbling or wetting. Irritability of the bladder, from any of its various causes, or a vascular urethral tumour, may give rise to similar symptoms ; but sounding will determine the diagnosis.

The *consequences* of persistent calculus are sometimes also peculiar ; it may be discharged through the vagina, by an ulcerative communication through the bladder and the vagina, forming a vesico-vaginal fistula ; or the stone may impede the descent of the foetal head in birth, as a rare cause of difficult parturition. I once saw an instance of this kind in the Royal Free Hospital ; a woman died after child-birth, and a stone was found in the bladder, the size of a hen's egg, consisting of phosphates encrusted with carbonate of lime.

Treatment.—The various operative procedures for removing calculi from the female bladder, are of four kinds :—(1) Dilatation of the urethra ; (2) Dilatation,

with partial slitting up, of the urethra ; (3) Lithotrity ; (4) Lithotomy, practised in four different ways.

Dilatation of the urethra may be accomplished *rapidly*, or *slowly* ; the former method was recommended by Sir A. Cooper when the stone is *small*, and that dilatation should be accomplished in a few minutes, —the method proposed by Tolet ; but that when the stone is *large*, it will be better to dilate slowly and gradually from day to day, until the requisite extension is accomplished, —the method suggested by Douglas. Rapid dilatation, under chloroform, is not painful, unlike the slower procedure ; but, according to Dupuytren's experience, and at variance with that of Mr Coulson, it is much more likely to be followed by *incontinence* of urine. Dilatation can be effected by various means ; solid or flexible bougies, gum-elastic catheters, prepared sponge, or other tents ; or by the cautious application of Weiss's female urethra-dilator, —a two-bladed instrument, worked by a screw at the handle, the speculum, or blunt gorget. After sufficient extension, a pair of forceps is introduced and the stone extracted. Stones of considerable size and weight have been thus removed from the female bladder ; notably, in a case by Coulson, the calculus weighing four ounces, and without any incontinence of urine having resulted. In one case I succeeded with forceps alone in extracting an oxalate of lime calculus, the size of an almond, which was impacted in the urethra of a young woman. The stone had been lodged there for some time, causing partial retention of urine ; and when removed, its exposed surface was obviously

“water-worn,” by constant attrition of the stream of urine in micturition.

The *recorded results* of urethral dilatation enable the operator to more accurately estimate the comparative merits of the rapid and the slow methods of this procedure; and the balance of evidence would appear to be not unfavorable to the former method. Thus, in 28 cases of urethral dilatation which Mr Bryant collected from the records of Guy’s Hospital, 4 only were followed by any incontinence of urine, and these were cases of slow dilatation; whereas, the remaining great majority of 24 cases, without any resulting incontinence, had been submitted to rapid dilatation (‘*Med. Chir. Trans.*,’ 1864). But slow or gradual dilatation, —in from twenty-four to forty-eight hours, has yielded very safe results in the hands of Dr Humphry; and where some of the stones were of large size. I suspect that this latter fact,—as relating to the *extent* of the dilatation requisite, according to the size of the calculus, would reconcile some of the apparent differences of result attributed to the rapidity or slowness of dilatation.

Dilatation, with *partial slitting-up* of the urethra, is available when the former procedure has been carried to the farthest extent consistent with safety; and yet the stone is too large for extraction without thus dividing the urethra. This method is described by Ambrose Paré, who saw the elder Collot perform the operation, but it was probably originated by Dubois. A grooved staff was introduced into the urethra, and on it a small incision was made vertically *upward*.

Sir B. Brodie revived this operation, and divided the urethra directly upwards under the symphysis pubis. Dilatation was then made with Weiss's instruments, to a sufficient extent for the introduction of the forceps and extraction of the stone. The objection to the upward incision is that it necessitates extraction of the stone where the space is most restricted.

The *direction* of the incision has been varied by Surgeons; some cutting directly downwards,—as recommended by Chelius, some obliquely downwards,—as Le Dran proposed, and others sideways.

Double incision of the urethra, combined with dilatation, was proposed by Dionis; the urethral orifice being divided horizontally on both sides. The probability of incontinence of urine resulting from urethral incision, rather than from dilatation alone, seems doubtful; Surgeons of great experience holding directly opposite opinions on this important issue. After double incision, in Dionis's cases, incontinence ensued in three out of every four patients thus operated on.

Lithotrity is preferable to either of the above methods,—urethral dilatation, or with incision combined—when the stone is of *large* size. This operation is far more easily performed in the female than in the male; and it is frequently more successful in its results; both these advantages having reference to the peculiar anatomical conditions of the urethral passage, already mentioned. But, a double depression may be found, as Civiale observes, in the posterior and inferior wall of the bladder,—an anterior, and a posterior

receptacle, formed by the projection of the neck of the uterus; and in either cavity, search must then be made for the calculus or fragments. In old women, a depression exists behind the internal opening of the urethra, wherein some difficulty may be experienced in using the lithotrite. *After-treatment* in the female, is, however, less liable to be attended with any difficulty by the retention of fragments in the bladder, or from impaction in the urethra; detritus, and even fragments of some size readily escaping through the large and easily dilatable urethra, facilitated also by the short extent and straighter course of the passage.

Lithotomy is also more readily performed than in the male, and it may be done in either of *four* ways.

The patient is placed under chloroform, and tied up in the position as for the operation in males; and a grooved staff is introduced into the urethra, which is hooked up perpendicularly under the symphysis pubis. A common bistoury, lithotomy-forceps, and scoop, are the only other instruments required.

(1) *Urethral* lithotomy is nothing more than incision of the urethra, carried up the passage, so as to divide also the *neck* of the bladder. Dilatation is then made sufficiently to allow of the completion of the operation, by extraction. A straight staff having been introduced into the bladder, its groove is directed downwards and outwards towards the ramus of the ischium, and the urethra divided obliquely downwards with a probe-pointed bistoury. This incision often intersects a small portion of the anterior wall of the vagina. Chelius recommends a vertical incision directly downwards,

thus dividing also the corresponding wall of the vagina. A bilateral section of the urethra has also been performed. Liston notched the neck of the bladder on both sides towards each ramus of the pubes, and then dilated for a few minutes until the finger could pass into its cavity.

The *lateral* operation, similar to that in the male, and practised originally by Frère Jacques, was revived by Dr Buchanan, of Glasgow. A grooved staff, curved or straight, having been passed into the bladder; an incision is made on the inner side of the left nympha, from a point about half an inch above the urinary meatus, and carried obliquely downwards and outwards, parallel with the rami of the pubis and ischium. By touches with the knife, between the rami and vagina, the latter being drawn inwards and protected by the left fore-finger, the staff is reached just in front of the neck of the bladder; then introducing the point of the knife into the groove, a slight urethral incision is made, inclining the blade downwards and outwards, and dividing the neck of the bladder. The opening should then be sufficiently dilated with the finger; the forceps are introduced and the stone is extracted.

Successful results have followed this operation; the wound healing readily, and the patient having the power to retain her urine. The operation seems to be especially suitable for female *children*.

(2) *Direct* lithotomy might be performed, as suggested by Celsus. This method of "cutting on the gripe" in women, consists in passing the fingers into the vagina, in order to press the stone forwards

against the neck of the bladder, and then making a transverse incision directly on the stone between the urethra and symphysis pubis. Lisfranc endeavoured to revive this method, in 1823; but it has justly fallen into disuse.

(3) *Vagino-vesical lithotomy* consists simply in making an incision through the vagina into the bladder, and thence extracting the calculus. A curved staff is passed so that its convexity shall appear in the anterior wall of the vagina, while the posterior wall is depressed with a blunt gorget or a duck-billed speculum. In this method of operation the urethra is avoided, and afterwards a female catheter is introduced along this passage into the bladder, and the edges of the vaginal incision are brought together by suture, as originally suggested by M. Coste, but first practised by Dr Marion Sims, and adopted in this country by Mr J. R. Lane. Vidal has thus operated in 30 cases without a single death, and Velpeau also testifies to the freedom from danger; there is generally no hæmorrhage, nor subsequent peritonitis; vesico-vaginal fistula, however, is a common result, unless the precaution be taken of closing the incision at the time of operation.

Incontinence of urine is apt to follow all these operations of lithotomy; although the last-named method is least liable to this result.

(4) *Supra-pubic lithotomy* in the female, is an occasional resource; when the stone is of very large size, or the pubic arch narrowed, as from rickety deformity, or perhaps both these complications are associated.

The *solvent* treatment of Stone in the Bladder—whether by means of *chemical* solvent agents, or by *electrolysis*, will be more conveniently noticed in connection with the Medical Treatment of Urinary Calculi.

CHAPTER IV

DISEASES OF THE PROSTATE GLAND

THE Prostate Gland, surrounding the neck of the Bladder, and commencement of the Urethra, is a body of small size,—resembling a horse chestnut, but apt to be very troublesome. It is subject to various Diseases; Inflammation, acute and chronic, Hypertrophy, or simple enlargement in advancing years, Atrophy, Cancer-growth, Cysts, Tubercular deposit, and Calculus. These diseases are identical in their nature with the same diseases of other parts; yet they are attended with symptoms peculiar to the prostate, and as affecting the bladder; which so far demand special treatment. Prostatic affections are often associated with diseases of the bladder, especially cystitis, and stone; so that, in practice, these cases are frequently found in the same patients.

PROSTATITIS, OR INFLAMMATION OF THE PROSTATE.—*Acute prostatitis* seldom occurs unconnected with inflammation of the bladder or of the urethra.—A sensation of weight and fulness is experienced about the neck of the bladder, rectum, and perineum; frequent and urgent desire to pass water, pain increasing towards the close of the act; with a constant straining

effort to empty the bowel, and great pain in defæcation, the motions having a somewhat flattened form; while an enlarged, and exquisitely tender state of the prostate is discovered on passing the finger into the rectum. The obstruction at the neck of the bladder, from further enlargement of the prostate, may soon render micturition difficult, and be followed by total retention. An attempt to pass an ordinary catheter encounters opposition, and is attended with great pain, when the instrument reaches the neck of the bladder. The constitutional disturbance is often severe; commencing with rigors, a high degree of inflammatory fever speedily ensues.

On inquiry into the causes of such an attack, prostatitis is usually found to be consequent on gonorrhœa, the inflammation having extended upwards to the prostate, or on stricture of the urethra; but it may have arisen from the rough manipulation of stricture or of lithotritry instruments; or have resulted from the irritation of a calculus, strong injections, or cauterization of the prostatic urethra. Cold and damp affecting the perineum, will also give rise to prostatitis, as by sitting on the grass in the dews of an autumn evening; and especially in gouty or rheumatic subjects. As occasional causes may be mentioned; alcoholic drinks, and inordinate sexual excitement, or hard riding on horseback; when, in either case, urethritis already exists. As an idiopathic inflammation it is very rare.

It terminates in the course of a few days, either in resolution or by suppuration; or it subsides into *chronic* inflammation.

Treatment.—The abstraction of blood from the perineum affords the greatest relief to acute inflammation of the prostate. Ten or twenty leeches should be applied, or cupping may be performed to the amount of six or eight ounces; followed by warm fomentations and hip baths. Pain is best relieved by opiate suppositories; as of pil. saponis co., five or ten grains. But the rectum must be kept free of any faecal accumulation, by the occasional administration of an oleaginous enema; while the febrile excitement may be subdued by antimonial salines, and low diet. Any retention of urine will probably yield under a full dose of opium, or necessitate the use of a gum-elastic catheter from time to time. By promptly adopting this plan of treatment, the inflammation may subside, without suppuration; leaving the prostate somewhat tender, enlarged and hardened, for a while; with a tendency to relapse, and some difficulty, or delay of the stream in the act of passing urine.

Abscess of Prostate.—Suppuration is preceded by throbbing about the neck of the bladder or in the perineum; the rectal swelling becomes softer to the finger, and fluctuation may be perceptible; at length the abscess bursts into the urethra and discharges through that passage, pus appearing in the urine; or in using a catheter for the relief of retention, the prostatic abscess is burst, and a quantity of matter is drawn off through the instrument. Usually, the abscess soon heals up; but if it remain open, it becomes a receptacle for urine, and this urinary abscess bursting into the perineum results in the formation of

fistula in perineo. Sometimes the original abscess discharges through the rectum, forming an urethro-rectal fistula.

Treatment should be prompt and decided, with the view of giving vent to any formation of matter, before the abscess communicates with the urethra or the rectum. As soon, therefore, as there is any tendency to perineal swelling, manifested by brawny induration without fluctuation, an incision should be made in the middle line, about three quarters of an inch above the anus, and cautiously deepened down to the matter; avoiding the rectum. For this purpose, the fore-finger of the left hand being passed into the bowel, a long and narrow, straight, sharp-pointed bistoury is used with the edge directed upwards. The depth to which the incision must be carried will be an inch and a half to two inches, and extended upwards in the raphé sufficiently to give a fair opening. Relief is immediate, just as when an acute tonsillar abscess is set free. If no pus escapes, the tension and pain are at once relieved, and matter may issue through the wound after a warm fomentation for a few hours. Puncture per rectum might be deemed advisable, when fluctuation can be distinctly felt in that situation. It may be a desirable precaution to draw off the urine occasionally, by means of a well-curved elastic catheter; or even to keep the bladder empty by retaining the instrument, if it can be tolerated. In passing the catheter, its point should be directed along the roof of the urethra, when the turn is made under the pubic arch.

Chronic inflammation results in enlargement of the

prostate ; a condition which is accompanied with frequent micturition, but a less forcible stream of urine than natural, followed perhaps by a drop or two of blood ; usually also there is a gleet discharge, the urine is milky and deposits more or less purulent matter on standing. Sexual intercourse is painful, and nocturnal emissions often occur. These symptoms are much aggravated by any perineal irritation, as by riding on horseback or prolonged walking exercise ; and also by errors of diet. The state of the prostate can be readily ascertained by examination with the finger through the rectum.

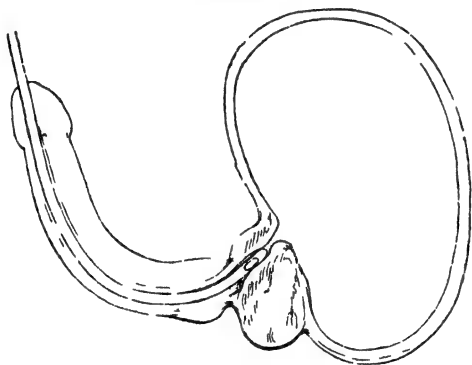
In the *treatment* of any such case, some benefit may be obtained from blistering the perineum, while the digestive organs must be carefully regulated, in order not to provoke the prostate by constipation or acidity of the urine ; then the iodide of potassium, with iron and quinine as tonics, may be administered with advantage. The sensitive state of the prostatic urethra—in itself a troublesome affection, can often be allayed by the occasional application of nitrate of silver, in the form of an armed bougie ; thus controlling the nocturnal priapism and emissions. But, as in all inflammatory affections of a chronic character, the course of treatment will have to be continued for a considerable period. Time, indeed, may be a better friend to the patient than any prolonged treatment.

HYPERTROPHY, OR CHRONIC ENLARGEMENT, OF THE PROSTATE.—This well-known prostatic affection is frequently met with in men after mid-life,—from fifty-five to sixty years of age ; never before the former period,

and seldom in extreme old age. This prostatic enlargement is almost a natural accompaniment of advancing years. It thus differs from chronic inflammation of the prostate, to which, after puberty, any age is liable; and it differs also in being an hypertrophied or overgrown condition of the gland. The parts of the prostate thus affected may be; the two lateral lobes, which are sometimes increased to four or six times their natural weight and bulk; or an outgrowth takes place from the central part of the organ, in a backward direction towards the cavity of the bladder, as a rounded or pyriform tumour or elevation of prostatic tissue,—the enlarged “middle or third lobe,” at the neck of the bladder; and this form of partial enlargement is the most common. Generally, however, the whole organ more or less partakes in the enlargement. Sometimes isolated tumours of prostatic tissue are produced, embedded, or as polypoid outgrowths. The vesico-urethral portion of the urethral canal undergoes certain alterations of length and direction, which tend to obstruct the passage of urine. The *prostatic* portion of the *urethra* becomes enlarged in its antero-posterior diameter, and narrowed transversely; instead of being, when distended, of nearly equal diameter both ways. It is also much elongated; measuring perhaps four inches from the orifice of the bladder to the membranous portion; instead of its normal length, one inch and a half. Its direction deviates from the natural passage; with enlargement of the middle lobe, the urethra rises abruptly as an angular curvature, instead of having nearly a straight line; thus presenting a complete step or “bar at the

neck of the bladder" (Fig. 28), over which an instrument must be made to pass before it will enter the cavity. A polypoid outgrowth from the middle lobe may act as a valve, overlapping the vesical orifice; and which, in the act of micturition, completely obstructs

FIG. 28.



(Liston.)

the passage of urine. With enlargement of either lateral lobe, bulging inwards on the canal, the lateral direction of the prostatic urethra is changed; curving to the opposite side, in this form of enlargement. The *vesico-urethral orifice* shares in these changes of shape; becoming crescentic, with the convexity turned upwards, when the middle lobe is enlarged; or turned to either side, as the enlargement of the lateral lobe on the opposite side encroaches on the prostatic urethra. The general result of these alterations in the urethral canal, is this; as a whole, it becomes elongated and more curved; while the prostatic

portion and vesical orifice may have also a tortuous course, somewhat like an italic *S*.

Various causes have been assigned for chronic enlargement or hypertrophy of the prostate.

All circumstances which tend to induce afflux of blood to this* part, may be productive of an hypertrophied condition. Thus, emotional excitement of a sexual kind, sexual excesses, over-stimulating food, irritant states of the urine, rectal constipation, sedentary habits, horse exercise, and such like, may be regarded as causes of this prostatic affection. But the initial cause or origin seems to be unknown.

Commencing insidiously, chronic enlargement of the prostate progresses perhaps for months or even years, without interfering with the act of micturition so as to arrest attention. At length, some delay, rather than difficulty, in passing water is experienced, the stream is full but less forcible than natural, it is concluded with an involuntary leaky dribbling, and sense of incomplete relief after apparently emptying the bladder. Micturition becomes increasingly frequent and urgent, a bearing-down weight is felt about the neck of the bladder and rectum, with pain in the glans penis and testicles, but which is not more acute after micturition. The urine voided appears healthy, although it be tinged with blood occasionally, or accompanied with some muco-purulent discharge. A man may have long suffered from some such symptoms; and if when examined, by introducing the finger up the rectum, the prostate be found enlarged and hardened, no doubt can then be entertained as to the nature of the case.

This pathological condition supplies the true explanation of all the symptoms. The enlarged prostate projects upwards into the bladder, and urine accumulates in the reservoir thus formed behind the prostate. The bladder is never emptied below the level of the prostatic eminence. Consequently, frequent, straining efforts are made; but the stream issues slowly, with less propulsive force, and ineffectually; the surplus urine only, or overflow passes off, leaving the residual urine, often in large quantity, still remaining below the prostate in the bladder. Even this occasional relief can occur only when the bladder is sufficiently distended to obey its own contraction, and the straining compression of the abdominal muscles, to overcome the resistance offered by the enlarged prostate. An involuntary dribbling of urine may take place at intervals, from over-distension; the incontinence of adults. Attacks of complete retention are liable to occur from any cause of temporary prostatic congestion; as by exposure to cold or damp, sexual excitement, or some error in diet; and such an attack is sometimes the first occasion of discovering the existence of prostatic enlargement. Under these circumstances, some amount of hæmorrhage, and perhaps muco-purulent discharge, not unfrequently happen, for the relief of congestion. Profuse bleeding may arise from transfixing a projecting portion of the prostate, in forcible catheterism.

The enlarged prostate as felt on passing the finger up the bowel, varies in size and consistence. Usually, it has the size of a large chestnut, or a small compressed orange, and of largest extent transversely,—

stretching perhaps across the bowel from side to side at the neck of the bladder; or either lateral lobe may be more enlarged. The consistence of this body is firm and resisting, sometimes soft or unequally hard at different parts of the surface. It may be impossible to ascertain the extent of the enlargement backwards, which is often beyond the reach of the finger. By tilting the base of the bladder upwards and forwards, some of the residual urine can be expelled; and by means of a catheter, several ounces of urine, to a pint or more, may be drawn off from the reservoir behind the prostate, although the act of micturition had just previously been performed.

In most cases, it is of no practical importance to carry the examination further. But *urethral* exploration with a catheter will supply information which rectal exploration cannot convey,—respecting the elongation and curve of the prostatic urethra. By passing a full-sized catheter of the ordinary length and curve, we obtain a standard of comparison. If the urine flows when this instrument has traversed not more than the usual distance—about six to eight inches, while the handle has not been depressed more than usual; there will be no evidence of prostatic enlargement. But, if the catheter has passed easily nine or ten inches, and yet no urine flows; while, following its course, the handle has become depressed to a greater degree than usual; there will assuredly be some enlargement of the prostate,—a judgment which may be confirmed by rectal exploration, so far as the lateral lobes are concerned. Then the *prostatic* catheter

should be used ; an instrument having a longer shaft by from two to four inches, and with a much larger curve. The increased length and the altered direction of the prostate canal can be estimated by means of this instrument ; the one fact, by observing the length of shaft introduced ; the other, by its depressed position when the point enters the bladder. Any lateral deflection of the instrument, to the right or to the left, when allowed to take its own inclination, will further indicate a greater degree of prostatic enlargement on the side *towards* which the handle inclines.

The *mode* of passing a prostatic catheter is peculiar in two important particulars ; the point of the instrument should be directed towards the upper floor of the urethra, and in turning under the pubic arch be hooked upwards,—so as not to slope downwards in the perineum ; the handle being depressed more than in passing an ordinary catheter. A small quantity of urine—perhaps an ounce, may be drawn off from the pouch formed by the enlarged prostatic urethra ; this flow taking place before, and as if, the instrument has entered the bladder, it is very apt to mislead the surgeon, who might therefore fail to complete the urethral exploration.

So far the prostate may be examined with the catheter, and by feeling with the finger in the rectum, at the same time ; thus ascertaining the thickness of the prostate, as well as the length and course of the prostatic urethra. If it should be thought necessary to explore the *vesical* portion of the prostate,—as to the enlargement of the middle lobe, with the fossa or

receptacle behind it at the base of the bladder, such examination can be made by means of a *sound* having a very short curve or only a beak. On passing this instrument into the bladder, the beak is turned down to sound the depth of the post-prostatic fossa,—possibly finding a stone there, which not unfrequently lies concealed behind an enlarged prostate; in withdrawing the beak forwards, the posterior limit of the prostatic enlargement can be defined, and the state of the middle lobe determined more clearly than by the up-curve in entering the bladder; and lastly, the crescentic shape of the vesical orifice may be indicated by gently turning the beak round to the right and to the left.

Having completed our examination of the prostate, so as to discover the enlarged dimensions of this body, the question of *diagnosis* can hardly be said to arise; but there are certain affections,—of the urethra and of the bladder, from which enlargement of the prostate should be distinguished.

Stricture of the urethra may be distinguished, partly, by the act of micturition; the stream of urine is discharged with diminished force, but the volume is also diminished, even to the smallest stream short of retention, and it has a broken, twisted, or dribbling character. Catheterism, however, supplies the more accurate points of distinction; obstruction is encountered always before the point of the instrument reaches the prostatic urethra, and usually before six inches of the instrument have passed; whereas eight or nine inches of the instrument will have disappeared ere an

enlarged prostate offers obstruction; and the handle must be depressed to a much greater degree than in passing stricture. The age of the patient also is different in the two cases; stricture always commencing before mid-life; enlargement of the prostate not until after that period.

Stone in the bladder is attended with somewhat similar symptoms to prostatic enlargement. But the vesical irritability and pain in the glans penis are more severe *after* micturition, for then the stone settles down on the sensitive base of the bladder behind the prostate; and both these symptoms are also then aggravated by walking or any movement whereby the stone shifts its position. The stream of urine often stops suddenly, by the stone falling over the orifice of the urethra; but this symptom may also occur from an overlapping outgrowth of the middle lobe of the prostate, as a rare form of prostatic enlargement. Bloody urine is a more frequent symptom of stone in the bladder; and the hæmorrhage which has a florid character, and is more copious, occurs especially *after* exercise, by attrition of the stone on the vesical mucous membrane. Sounding affords, however, the only conclusive evidence of stone. The diagnosis becomes far more doubtful in the case—not unfrequently met with—of an enlarged prostate *coexisting* with stone in the bladder, and masking its symptoms. If the calculus lies in the fossa behind the prostate when enlarged, the pain in the penis and vesical irritability will be mitigated or even absent; owing to the removal of the foreign body from the sensitive

neck of the bladder. Careful sounding may then discover the stone in its bed, almost under cover of the prostate; and on passing the finger up the rectum, that body is more distinctly found to be enlarged.

Any *tumour* of the bladder so far resembles an enlarged prostate, that both project into the cavity of this organ; but careful sounding with the beaked instrument will probably enable the Surgeon to define the different locality of the two outgrowths; and he may have his diagnosis confirmed by the distressing irritability of the bladder, the severe pain, the copious and recurring hæmorrhage; and at length perhaps he discovers some characteristic structural elements of the tumour, discharged in the urine, or such direct evidence is brought to light by inspection with the microscope.

Atony of the bladder differs from prostatic enlargement in the twofold fact; that, when a catheter is introduced, no urine or scarcely any flows by the propulsive action of the bladder,—the stream is simply a passive discharge; and that this current cannot be much accelerated by any efforts of the patient. *Atony* may, however, itself be due to the over-distension consequent on enlargement of the prostate. In *paralysis* of the bladder there is the same passive stream of urine, when a catheter is passed; but there is also inability on the part of the patient to expel the urine by the action of the abdominal muscles,—this inability being proportionate to the completeness of the paralysis. Other parts, moreover, are involved, as the

lower extremities ; and this paralytic condition proceeds from injury or disease of the nervous centres—brain or spinal cord. The absence of any enlargement of the prostate should not be overlooked.

In concluding the history of this chronic affection, I have yet to notice its consequences, and modes of termination,—unhappily tending to a fatal issue.

Chronic cystitis commonly ensues from the habitual retention of urine, and distension of the bladder. An abundant secretion of viscid mucus or purulent matter, streaked with whitish phosphatic deposit, and sometimes tinged with blood, is voided in the urine ; which is now alkaline, and of a pungent ammoniacal or foetid odour. Occasionally, a deposit of urates and uric acid takes place, in connection with a gouty diathesis. The quantity of urine passed varies much from day to day ; being usually much above, although sometimes below, the average healthy standard. In consequence of the habitual retention, and inflammatory affection of the bladder, constitutional disturbance at length supervenes. The patient's general health declines, from broken rest, in frequent efforts to relieve the bladder, and from the exhaustion induced by chronic cystitis ; he becomes sallow and dejected, he loses flesh and strength, and ages fast. Recurring attacks of complete retention throw him further back. Or, instead of this *gradual* decline, a *rapid* depression may occur from ulceration or sloughing of the bladder, with repeated hæmorrhage, or from profuse purulent discharge. *Uræmia*, from suppression of urine, sometimes closes the scene.

After death, certain pathological conditions of the urinary organs, will be found to have resulted from the mechanical and backward effect of long-continued partial retention of urine. The *bladder* is thickened, principally in its muscular coat; the hypertrophied muscular bands project inwards in the form of prominent cords, between which the mucous membrane protrudes externally in pouched depressions,—under the constant pressure of the retained urine; thus the bladder has become fasciculated and sacculated. At the base or lower fundus of the bladder, a fossa or receptacle has formed behind the enlarged prostate, capable of containing perhaps several ounces of the ammoniacal, fœtid urine; and in which muco-purulent matter, and phosphatic deposit, are also apt to accumulate. The vesical mucous membrane has generally a greyish-slate colour. Backward pressure of the urine distends, and eventually dilates the *ureters*; and the secreting substance of the *kidneys*,—in their pyramidal and cortical portions, are atrophied; resulting perhaps in sacculated remnant kidneys. Hence, suppression of urine, and uræmia.

In the *treatment* of chronic enlargement of the prostate, palliative measures alone have any effect; this prostatic hypertrophy, naturally incident to advancing years, being incurable. The surgeon must have in view, the relief of retention, by catheterism, or other operative interference when necessary; and the prevention or relief of chronic cystitis, and the maintenance of the general health.

Having regard to the constant *retention* of a certain

quantity of residual urine in the bladder ; the organ should be emptied mechanically, at least once daily, or perhaps twice or three times ; as occasion may require, owing to the amount of obstruction and varying degree of retention. The *prostatic* catheter is larger-sized, longer and more curved than an ordinary catheter ; and thus being adapted to the corresponding alterations in the urethral canal, the urine can be more conveniently drawn off by this instrument. The three points—previously mentioned—should be here remembered, in passing this instrument into the bladder ; not to mistake the dilatation of the prostatic urethra for the bladder, an ounce of urine perhaps thence escaping as if the catheter had entered its cavity ; the up-sweeping of the point of the instrument under the pubic arch, with depression of the handle sufficiently between the thighs ; so as to curve upwards into the bladder, and thus also avoid hitching against any enlargement of the middle lobe. Care should be taken to empty the receptacle behind the prostate, by turning down the point of the catheter, before withdrawing it. The patient should be taught to pass the instrument in his own person, that he may be enabled to relieve himself. A gum-elastic catheter, of large size, will then be more convenient and safer than the silver instrument ; the patient passing it bit by bit. When the point has reached the prostatic urethra, the *stilette* should be withdrawn, that the curve of the catheter may glide upwards into the bladder. Mercier's *sonde coudée*, a beaked elastic catheter, will prove serviceable when the middle lobe is enlarged ; or the *sonde bicoudée*, having

a second beak, is thus adapted to mount up more readily into the bladder. As a rule, it will be unnecessary and undesirable to leave the catheter in the bladder; but if requisite to procure ease and sleep, this may be allowed, as during the night. The gum-elastic, or vulcanized india-rubber catheter, is then preferable, as being less irritant to the mucous membrane. By thus habitually relieving the retention of urine, the patient's existence becomes more tolerable or even comfortable, and his life may be considerably prolonged.

But supposing no instrument can be got into the bladder, other methods of gaining an entry may be resorted to. They are, forcible catheterism or tunnelling the prostate, puncture of the bladder through the rectum, or puncture above the pubes. Of these three methods; forcible catheterism is sanctioned by Brodie, Liston, Spence, and other surgeons of large experience, as a safer procedure than puncture per rectum, or supra-pubic. The instrument having been thrust through the obstructing portion of the prostate, is left in the bladder for about forty-eight hours, to establish a false passage for its re-introduction. But I have known severe prostatitis to be thus induced, and more complete obstruction; or copious hæmorrhage has been caused, more blood passing back into the bladder than escapes through the urethra; and in one case, I am sure the patient bled to death. I decidedly prefer having recourse to puncture of the bladder through the rectum; but this, and the other procedure, above the pubes, will be considered and described in the treatment of stricture of the urethra.

The tendency to chronic cystitis from prostatic enlargement is partly averted by preventing retention ; at the same time, the diet should be carefully regulated, and exposure to cold or damp avoided ; in short, any cause of any disordered state of the urine, or of determination of blood to the bladder. The remedial treatment of this vesical affection has already sufficiently engaged our attention. Nor need more be said respecting the support of the general health.

Atrophy of the Prostate sometimes occurs in old age ; or it may be found in early adult life, then probably being an imperfect development of this gland, or connected with malformation. No special symptoms are known, nor does this condition admit of any remedial treatment.

CANCER OF THE PROSTATE.—Occurring less frequently as a secondary deposit, than as a primary disease ; prostatic cancer is almost always encephaloid, and sometimes combined with melanotic matter ; scirrhus is rarely if ever met with.

The prostate undergoes enlargement, and the symptoms are those of the simple chronic enlargement or hypertrophy. But the patient complains of severe pain, shooting into the rectum, up the sacrum, and down the thighs ; he is alarmed by repeated and profuse hæmorrhage in passing water ; and his bloodless, spectral appearance tells the story of suffering and exhaustion. On passing the finger up the bowel, a tumour is at once felt, which—as compared with an ordinarily enlarged prostate—is of larger size, harder, and perhaps irregular ; or, at a later stage, it feels

softer and fungating. The lymphatic glands in the groin are found to be affected, and by careful palpation, some enlargement of the lumbar glands may be detected. This concurrence of symptoms will probably suffice to indicate the nature of the prostatic disease,—or at least the difference from ordinary glandular hypertrophy. It has been said that the urine may exhibit, under the microscope, cancer-cells; but the resemblance of the epithelial cells, would render this evidence doubtful. But the surgeon will take into account, the rapidity with which the symptoms have made their appearance; the disease running its course from first to last, in a period not longer than from a year and a half to five years in adults, and from three to nine months only in children; and that this malignant prostatic enlargement is not at all peculiar to advancing age.

Palliative *treatment* may relieve the distressing symptoms of this disease. The partial retention would seem to warrant the use of an elastic catheter; but instrumental interference should be avoided as long as possible, and then catheterism should be performed with the gentlest manipulation, not to irritate or injure the painful and bleeding prostate. Anodynes, in the form of opium or conium more particularly, may be administered both by the mouth and rectum. If, besides thus allaying the severe pain, as the disease progresses, sleep can be procured, the patient may well feel thankful for that double boon. Attacks of hæmorrhage must be treated as explained in connection with hæmaturia. But the bleeding of a bleeding-growth, such as encephaloid cancer, is even less con-

trollable than its painful character. The consequent exhaustion will require all the support which can be given by tonics, and a nourishing diet. Iron and quinine, in their various preparations are the most efficacious; while the choice of food should be regulated as the digestion responds to the various resources of experience. The general health and strength may thus be sustained, and life prolonged.

A *cystic* condition of the prostate may be mentioned more in relation to its pathological interest, than as having much practical importance with regard to its diagnosis and treatment. In old age especially, the substance of the prostate is often beset with numerous cavities, of an irregular shape, apparently dilated prostatic follicles, and communicating with the ducts of the gland. Minute concretions or prostatic calculi of larger size are apt to form in these cysts. Then again, the whole substance of the gland may have become converted into a cyst or abscess, resulting from long-continued suppuration. Occasionally, an *hydatid* cyst forms between the base of the bladder and the rectum. This extra-cystic condition is attended with retention of urine, and distension of the bladder; simulating the symptoms of an enlarged prostate.

Tubercular deposit very rarely affects the prostate, and always secondary to some other part of the genito-urinary tract as the primary seat of deposit. The kidney is affected first, or the testicle. Generally, the prostatic disease is associated with phthisis pulmonalis. Prostatic tuberculosis is met with usually between the ages of twenty-five and fifty-five. The

symptoms are in no way peculiar or well marked. A phthisical-looking man, or scrofulous child, is troubled with frequent and painful micturition, as if a case of vesical irritability from any other cause; there is some obstruction to the free passage of urine, and slight hæmorrhage recurs at intervals. Rectal examination discovers some amount of prostatic enlargement. Subsequently, however, with suppuration and discharge, the prostate becomes smaller than natural, and the urine purulent. The suspicion originally entertained as to the nature of the disease, is confirmed by the progress of this prostatic affection.

Treatment must be conducted on general principles, and have reference to the constitutional diathesis.

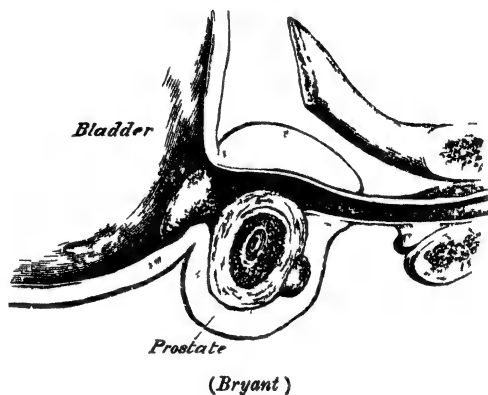
PROSTATIC CALCULUS.—The prostate gland, like other glands, is liable to an inspissation of its secretion, forming a nucleus, around which phosphatic concretion takes place, within the follicular structure. This mode of origin, and situation, distinguish true prostatic calculus from urinary calculus which may have only lodged in the prostate. The physical characters of these calculi are such as may be easily recognised. Their colour is commonly a brown chestnut, sometimes black, red, or white; rarely transparent or like pearl-barley; of softish or hard consistence; but their form is very irregular, facettèd, triangular or square; and their size varies from that of granular sand to a poppy-seed or cherry-stone. In point of number also; 1, 2, 3, or more, even to 100, may have formed, like a bag of marbles. By constant attrition, the facets become smooth and polished. Continued deposition of phos-

phatic matter at length produces a larger calculus ; which encroaches on the rectum, or comes forward out of the mouths of the distended prostatic pouches into the prostatic urethra ; thence extending forwards, or backwards into the bladder, it forms a prostatic-vesical calculus. Sometimes, one or more prostatic calculi become detached, free and moveable in an open duct. These enlarged calculi have a very irregular or branched appearance. A remarkable prostatic calculus was presented by Dr. H. Barker to the Museum of the Royal College of Surgeons. It has a pyriform shape ; measures in length nearly five inches, in circumference at its thickest part, four inches and five-eighths ; and weighs three ounces and a half. The stone consists of twenty-nine pieces, the facets of which are regularly fitted together ; indicating that its formation took place in the crypts of the prostate, separately, and that the pieces coalesced by subsequent absorption of the glandular substance ; thus resulting in this multiple calculus.

The *symptoms* to which prostatic calculi give rise, depend principally on their size. When small, there may be no symptoms, or such slight inconvenience as not to attract attention. When of larger size, they are attended with pain and weight in the perineum, and uneasiness at the neck of the bladder ; there is frequent micturition, sometimes retention, and difficulty in the emission of semen, although attacks of priapism may have misled the sufferer to more frequent sexual intercourse. All these symptoms point to an enlarged and irritated prostate ; and, by urethral or rectal exploration, one

or more stones can be touched with an instrument, or felt through the prostate with the finger (Fig. 29).

FIG. 29.



On passing a sound through the urethra, a distinct click or grating is heard and felt, just before the beak of the instrument enters the bladder; a deeply imbedded calculus may be felt, on passing the finger up the rectum; or by simultaneous examination with the finger and sound. A large number of small stones communicate to the finger a crackling or grating sensation, like that of small marbles in a bag.

As the result of prolonged irritation, suppuration may ensue, forming prostatic abscesses.

Having found a calculus in the prostate, what *treatment* should be adopted? When there are no urgent symptoms, the case may be wisely left alone, so far as regards any attempt to remove the stone by operative interference. Symptoms of irritation can perhaps be

subdued by opiate suppositories, and careful regulation of the bowels to prevent any rectal constipation ; while retention of urine is relieved by using the catheter as occasion requires. If the calculi are small and moveable, they may admit of extraction through the urethra, by means of a long urethral forceps. But this mode of operation is not easily accomplished. When the stones are large, and not more than two or three in number, median lithotomy should be performed, and extraction effected with scoop or forceps. A larger-sized calculus had better be removed by the lateral operation.

Sometimes, the Surgeon has to deal with a urinary calculus or fragment, lodged in the prostatic urethra ; here the urethral forceps can more often be employed with advantage ; or failing thus to remove the stone, it may be pushed back into the bladder, and submitted to lithotrity or lithotomy.

Lastly, the occasional co-existence of prostatic and vesical calculus presents a difficulty in the way of the lateral operation. Yet, under these circumstances, this mode of removing both calculi may alone be practicable.

CHAPTER V

DISEASES OF THE URETHRA

No branch of Surgery possesses a more abundant literature than Urethral Diseases; and no subject, in my judgment, has been more overwritten. These diseases have been incidentally alluded to, as associated with vesical and prostatic affections, and may be thus enumerated. (1) Inflammation of the Urethra, or Urethritis, and its more specific form, Gonorrhœa; (2) Stricture or contraction of the canal, in some part or parts of its extent,—as a structural or organic and permanent condition, or as a spasmodic, or an inflammatory state; (3) Tumours occasionally; (4) Urethral Calculus. The results of Urethral obstruction comprise; Retention of Urine; Extravasation; Rupture of the Bladder; and Urinary Fistulæ;—penile, scrotal, perineal, urethro-vaginal, and vesico-vaginal fistulæ.

URETHRITIS.—*Simple* inflammation of the urethral mucous membrane may arise from various causes, at any age, and in either sex. Any one, who may be thus affected, experiences heat, pricking, and tension in the urethra, for a day or two, with some scalding sensation in passing water; symptoms which are followed by a muco-purulent discharge. Sometimes, the only

symptom is this whitish discharge from the urethra, unaccompanied with any inflammatory character.

The *diagnosis* of this urethral affection, in either form, is very important, from its resemblance to Gonorrhœa. In the *active* condition of simple urethritis, the distinction from Gonorrhœa is extremely difficult; in the *passive* condition, it resembles gleet, but differs in the thicker and more opaque character of the urethral discharge. The causes of simple inflammation of the urethra differ also from that of gonorrhœa which arises from a specific contagion; though here it must be confessed, the line of distinction is even less definite.

Certain constitutional diseases, gout, rheumatism, scrofula, and the influence of particular medicines, as guaiacum or Cayenne pepper, frequently induce urethritis. These causes seem to affect the urethra through morbid states of the urine, as when it is loaded with lithic or with oxalic acid; thus producing *direct* irritation in the passage of such urine. They give rise to the active form of urethritis, and the discharge usually disappears immediately upon the development of the constitutional disease. Scrofulous urethritis is, however, apparently a local manifestation of the general disease, just as there may be a discharge from the nasal mucous membrane. *Distant* irritation, as gastric derangement, worms in the intestines, or teething, may also excite an urethral discharge; but this is of a passive character. Local causes of various kinds are not unfrequently the occasions of urethral irritation; as the passage of instruments, sexual intercourse or excitement, the introduction of vaginal discharges,—

such as the menstrual fluid, or leucorrhœal matter. Here again, the discharge is usually passive.

All these causes should be taken into consideration before pronouncing a professional judgment as to the particular cause in any case of urethritis. Thus, in a young child, the existence of vaginal and urethral discharge, is not absolute evidence that a rape has been committed; and in persons who are subjects of stricture and irritable urethra, a discharge apparently gonorrhœal sometimes exists, or appears after sexual intercourse or excitement, a debauch, or other cause of urethral irritation.

Simple urethritis generally subsides in a week or ten days, unlike gonorrhœa which continues some weeks or even months. But the discharge often becomes chronic in gouty persons, or when associated with stricture.

Treatment consists in removing any cause of urethral irritation, and allaying the inflammatory symptoms. Thus, in a gouty or rheumatic case, both these indications may be answered by the administration of alkaline, saline aperients, combined perhaps with colchicum; aided by a moderate and non-stimulating diet. When the discharge has become passive, weak astringent injections,—as of the diacetate of lead, alum, or sulphate of zinc, will gradually arrest the urethral secretion and complete the cure. I never use the two latter forms of astringents, nor find it necessary to have recourse to copaiba or cubebs.

As associated with stricture, urethritis may occasion a temporary retention of urine, partly spasmodic.

Then, in addition to what is termed antiphlogistic treatment, the relaxing influence of opium, or opiate suppositories, and a warm hip-bath, will usually overcome the obstruction. The use of a catheter should be postponed until relief cannot be otherwise obtained.

Gonorrhœa or *Blennorrhagia*.—This form of urethritis is attended with muco-purulent discharge, of a *specific* character; and is generally produced by contagion or contact with a *similar* discharge, usually during sexual intercourse. It may affect, and infect, either the male or female.

In the *male*, the urethra is the seat of gonorrhœa, and particularly the anterior portion of the mucous membrane,—as far as the fossa navicularis within the glans penis; but the urethral inflammation sometimes extends backwards along the whole length of the passage, and may even involve the mucous membrane of the bladder, in extreme cases. When gonorrhœal inflammation subsides into a chronic state, the bulbous portion of the urethra is more especially affected, the intermediate anterior portion up to the glans being comparatively free. Other portions of the genital mucous membrane are often *secondarily* involved, as that of the prepuce and glans.

The symptoms of gonorrhœa differ in the course of the disease, and which may thus be divided into four tolerably definite stages. Commencing generally from the second to the fifth day after contagion; a short period of urethral irritation, is followed by acute inflammation, which subsides into a declining or chronic stage; terminating perhaps in gleet, a chronic

state of peculiar discharge which does not always supervene.

Urethral irritation is attended with very slight symptoms; an itching or tickling sensation in the meatus, its lips have a florid red, and puffed appearance, and are glued together by a scanty, viscid, clear and colourless or slightly opalescent secretion. In passing water, some smarting is experienced, but no scalding—no ardor urinæ. This stage lasts from a few hours to two or three days.

Acute inflammation gives rise to the discharge of a purulent secretion, having a thick, creamy consistence, an opaque and greenish yellow colour, it can be pressed out of the urethra in sulphur-looking drops, and is usually so abundant as to stiffen the shirt in patches; an acute scalding pain is felt in passing urine, which is voided with some difficulty in a diminished or forked stream, or in spasmodic jerks, and with increased frequency; although the patient refrains from micturition as long as he can contain, regarding this procedure as quite a little operation. The glans penis is turgid and of a bright cherry-red colour, the urethral canal is swollen and cord-like to the touch; the prepuce may become œdematous, and at length the whole penis looks and feels turgescient. Should the inflammation pass back to the bulbous urethra, a sensation of weight in the perineum will be experienced, and reaching the prostatic urethra, a bearing-down weight about the anus is superadded. The heavy and enlarged penis seldom remains pendent and quiescent for many hours by day or night; under any rubbing

irritation of the dress, or from warmth in bed, erections often occur with troublesome inconvenience; or *chordee* not unfrequently arises, in the form of a painful arching or twisting of the penis downwards during erection, a penalty inflicted in oft-repeated attacks. This bent position of the organ in erection, seems to be the result of lymph-effusion around the urethral canal, producing an inextensible state of the corpus spongiosum at the part affected. Whenever, therefore, an erection would take place, as the cavernous body of the penis becomes distended, the unyielding spongy urethra acts like the string of a bow, and bends the penis downwards. Another explanation is, that *chordee* arises from spasm of the muscular fibres around the urethra.

The characteristic discharge and scalding micturition, constitute what is vulgarly called the "clap" in England, and "chaudpisse" in France. Some feverishness may accompany this acute inflammatory stage of gonorrhoea; but often there is little constitutional disturbance. The average duration of this stage is from one to three weeks; its continuance varying according to the number of previous attacks and the habits of the patient.

The *chronic* stage is denoted by the altered character of the urethral discharge; the pus subsides into mucopurulent matter, which is thinner and less copious; and the scalding reverts to smarting or only a soreness in micturition. In about another three weeks, the gonorrhoea may pass off,—under treatment; but it rarely terminates spontaneously in less than

three months. During a severe and protracted gonorrhœal discharge, the general health undergoes a marked depression ; so that the individual may be almost known by his haggard, pallid, and listless appearance.

Gleet.—Blennorrhœa or gleet must be regarded as the sequel, rather than the concluding stage of gonorrhœa ; for it does not invariably ensue. The urethral discharge has now become a thin, nearly clear and colourless, or almost watery fluid, oozing in small quantity, or so scanty that it has to be pressed out of the meatus for examination ; no scalding or other inflammatory symptoms remain ; yet this discharge is persistent—lasting for many months or even years. Thus we speak of an old-standing, gleety urethral discharge. It may be maintained by certain constitutional conditions ; a scrofulous, rheumatic, or gouty diathesis ; a lymphatic, weakly temperament ; or simply by a state of debility. The discharge retains its contagious nature for a long or indefinite period ; and it is ever liable to be developed into a more virulent puriform secretion by slight exciting causes. Sexual intercourse, therefore, is always unsafe, so long as *any* discharge exists, of whatever kind or as the smallest oozing of secretion.

I have already noticed the *diagnosis* of gonorrhœa from simple urethritis. No positive distinction can be trusted from the appearance of an urethral discharge, its contagious character, or from its having been produced by contagion. As Ricord truly observes, “Gonorrhœa often arises from intercourse with women who themselves have not the disease ;” and yet more

explicitly, Diday affirms, "that from the very fact of a woman having a discharge, no matter what its origin, she is liable to give a discharge to a man." Bumstead bears similar testimony as to the possibly non-specific origin of gonorrhœa in a man from an uncontaminated woman. It is, therefore, of the utmost social importance not to overlook the difficulty or impossibility of a diagnosis, as affecting the moral character of any woman, and who as a wife or mother would suffer the most wrongful and cruel imputation by a rash or erroneous professional judgment; blighting also the domestic happiness of those with whom they are connected. Nor need I dwell on the further responsibility of the practitioner respecting any such question, when made the subject of Medico-legal inquiry; as perhaps criminally affecting a chaste woman. In the male sex also, *any* persistent urethral discharge,—whether from gonorrhœa, as gleet, or of non-specific nature, may equally prove contagious to a woman.

These considerations give a wider significance to the *causes* of gonorrhœa than was formerly understood. Gonorrhœal matter or virus, and occasionally any other discharge,—as menstrual fluid or leucorrhœal matter, or even the ordinary uterine or vaginal secretions, may severally communicate, or give rise to true gonorrhœa. The distinction between gonorrhœa and simple urethritis, in virtue of the *specific* nature of gonorrhœal pus, is now generally acknowledged to be no longer tenable. The contagious character of gonorrhœal pus is more virulent, and the symptoms induced are generally more severe; but, from a causative point

of view, the only distinction is, that simple urethritis arises from other causes,—constitutional and local, as well as from any contagious discharge.

The following additional practical facts, although not perhaps exclusively characteristic of gonorrhœal contagion, appear to be well established. 1. The disease is not communicable by sexual intercourse *before* the discharge appears. 2. After the discharge is established, if the urethra be previously washed out by means of a water-injection, the disease will probably not be communicated. 3. The matter retains the power of infection for an indefinite period; in one case Titley found that a girl had communicated the disease immediately on leaving the Magdalen Hospital, after a seclusion of one year; and in another case, according to Hunter, after two years' seclusion. 4. With gleet, two persons thus affected, may have intercourse with impunity; but either of them will communicate gonorrhœa to a sound person. 5. The violence of the symptoms depends very much on constitutional conditions, as the gouty diathesis, and habits of life, as intemperance; consequently, the same woman may give a very mild gonorrhœa to one man, and a most severe one to another. 6. The first attack of the disease is generally the most severe; a kind of urethral tolerance being commonly induced by repeated attacks. 7. The severity and the continuance of gonorrhœa are often inverse; it is most severe in young and plethoric persons, in the gouty or rheumatic diathesis, and in the first attack; but most obstinate in scrofulous and phlegmatic constitutions, in persons affected

with chronic skin diseases, and after repeated attacks. 8. The disease seems to be much milder now than formerly.

The *generation* of gonorrhœa, apart from exposure to any discharge, is a question which may be so far entertained that it has not been entirely disproved; but many apparent cases of origin are rendered very doubtful by the persistently contagious character of the slightest gleet discharge. In relation to *syphilis*, the virus of gonorrhœa differs entirely in its nature from that of chancre or of chancroid; neither disease being capable of reproducing the other under any circumstances. The two diseases are distinct; not convertible.

An ordinary case of gonorrhœa passes through an unchequered course, until the discharge runs itself off. But several morbid conditions of the urethra or of adjoining parts may *complicate* the natural history of this disease. *Chordee*, a bent and painful erection of the penis, has been already noticed. Urethral *hæmorrhage* is apt to occur, from rupture of the engorged vessels during violent erections, and especially in *chordee*. This event is unimportant, the loss of blood usually being slight, it affords relief. Inflammation and suppuration of some of the *mucous follicles* of the urethra may occasion some temporary obstruction; until the abscess bursts into the urethra, or perhaps externally, as a less favorable issue. Irritation or inflammation of the *urinary organs* is a far more serious complication of gonorrhœa; sometimes affecting the posterior portion of the urethra,—giving rise to severe

perineal pain, with spasmodic stricture, and more or less retention of urine; sometimes extending back to the bladder,—as denoted by the more urgent and painful micturition, with mucous deposit in the urine; or there may be the symptoms of renal irritation amounting even to nephritis,—announced by pain in the loins, shivering, vomiting, and albuminous, bloody or purulent urine. This state, with or without cystitis, is likely to be induced by early or strong urethral injections, intemperance, or the use of copaiba in large doses. Inflammation of the *inguinal lymphatic glands*, or *sympathetic bubo*, occurs during the second or inflammatory stage of gonorrhœa. But such buboes rarely proceed to suppuration, unless when subjected to irritation, or in persons of a scrofulous and debilitated constitution. *Balanitis*, an inflammatory affection of the mucous membrane of the prepuce and glans, is known by a thin, opalescent discharge from this part, often profuse and excoriative. Persons who have a long prepuce, are most liable to it; but it is engendered by uncleanness, hot weather, or disordered health. As the result of swelling of the prepuce and glans, *phimosis* or *paraphimosis* is not unfrequently met with in conjunction with gonorrhœa. Thus, the prepuce cannot be retracted, or not easily, behind the glans, so as to uncover it; or, the prepuce cannot be drawn forwards from behind the glans, so as to cover that part of the penis. Various cutaneous eruptions on the prepuce are occasionally concomitants of gonorrhœa. *Herpes præputialis* appears in the form of small vesicles, containing a thin opalescent fluid; and which

are disposed in clusters of two, three, or four, upon the internal or external surface of the preputial fold. Roseola, pityriasis, and psoriasis, sometimes make their appearance; usually, from six weeks to three months after the commencement of gonorrhœal discharge.

A patient having escaped any mishap in the course of gonorrhœa, is yet liable to the *consequences* of this urethritis. *Orchitis*, or inflammation of the testicle, is not uncommon; commencing as epididymitis, and resulting in a swollen state of the organ. Gonorrhœal *rheumatism* or *synovitis*, sometimes arises from sudden arrest of the discharge, or after exposure to cold; the metastatic inflammation affecting one or more joints; usually the knee, and often both knees. In some cases, the discharge continues. The synovitis is marked by an abundant serous effusion, and the disease terminates without disorganisation, in a few weeks. It may, however, proceed to ulceration of the cartilages, and continue for months or a year or two. In one such case, under my care, the knee-joint became firmly ankylosed. Gonorrhœal *ophthalmia*, an acute purulent inflammation of the conjunctiva, may occur in consequence of the accidental application of the urethral discharge to the eye,—an inoculation of gonorrhœal matter to another mucous membrane. This mode of origin does not seem to be always indisputable; for both eyes are often affected, and usually at an interval of a few days, the eye attacked last generally suffering least. Gonorrhœal *sclerotitis*, an inflammatory affection of the sclerotic or fibrous coat of the eye, may

be of a rheumatic character. Occasionally, gonorrhœa or gleet is followed by *prostatorrhœa*, a chronic inflammation of the prostate gland; characterised by the discharge of a few drops of clear, transparent, or slightly turbid viscid mucus, after micturition or any straining effort of defæcation. This fluid is not semen, as it contains no spermatozoa. There is also much irritability about the neck of the bladder, and sensitiveness of the prostatic urethra in passing an instrument; with loss of strength, and mental languor or hypochondriacal lowness of spirits.

The *treatment* of Gonorrhœa varies according to the stage of the disease.

During the incipient stage—*urethral irritation*—it may be possible to prevent the accession of the inflammatory stage, by means of “abortive” or “revulsive” treatment; which comprises astringent urethral injections, and the specific influence of copaiba or cubebs. But any such agents, if used for that purpose, are very hazardous, by perchance exciting intense inflammation. So far as opportunity may offer for this practice, I believe it is generally abandoned.

Inflammatory stage—acute and chronic.—From the commencement a gonorrhœal purulent discharge, reducing measures, followed by suppressive injections, may be employed,—according to the degree of urethral inflammation. When *acute*,—with an abundant, thick, opaque, yellow, or creamy discharge, and scalding in passing urine; the appropriate treatment consists, in gentle saline, alkaline, aperient medicine, an unstimulating diet, abstinence from wine, beer, or spirits, with

rest and recumbency. As a topical application, immersion of the penis in very hot water, for a few minutes, is said to afford great relief. When the inflammation has passed into the *chronic* stage,—with a diminished, thinner, and clearer discharge, and the absence of scalding in micturition, the previously reducing measures should be discontinued; and succeeded by acid tonics, or perhaps copaiba or cubebs, and astringent urethral injections may be used. In *gleet*,—the discharge having now become scanty, thin, clear, and colourless, as a watery oozing from the urethra, and lasting for a considerable period; the same suppressive measures will also be appropriate.

By the foregoing plan of treatment, I have almost invariably prescribed with success, in some thousands of cases. Commencing with an aperient and alkaline mixture,—containing sulphate of magnesia, in about drachm doses, with a little senna, and the sesquicarbonates of soda and ammonia, in doses sufficient to nearly neutralize the urine; in three weeks or more, the urethral inflammation will have safely subsided; the patient having abstained from any indulgence in wine or other alcoholic beverage, and stimulating food, especially peppers and condiments. The discharge has now undergone the characteristic change in quantity and appearance to that of the chronic stage; and the scalding pain in micturition has also ceased, leaving only a slight smarting or soreness in passing urine. Then, the discharge may be *safely* suppressed, gradually, by using an injection twice a day; consisting of about ʒij of the liquor plumbi diacetatis to ʒij of distilled

water. Other injections, if not preferable, may be preferred. Thus, the subnitrate of bismuth in mucilage, x grs. to ℥j of water, with a little morphia or belladonna; nitrate of silver i—ij grs. to ℥j; chloride of zinc i—iv grs. to ℥iv; sulphate of zinc i gr., gradually increased to iv grs., to ℥j; sulphate of zinc and acetate of lead ana xxx grs. to ℥vj, an injection long in use at the old Lock Hospital; or acetate of zinc, xii grs. to ℥iv of water, the favourite injection of Sigmund, Milton, and Bumstead. In obstinate *gleet*, the bichloride of mercury may prove successful; $\frac{1}{4}$ gr. to ℥j of water. Before using any injection, the patient had better pass his urine, in order to clear the urethra of gonorrhœal matter, which would prevent contact with the mucous membrane; and also to avoid the necessity of emptying the bladder again for some time, care being taken to drain away any urine from the urethral canal. These two latter precautions have regard to any decomposition of the injected solution by the action of the urine. Owing to such change, a lead-injection becomes opaque and curdled when discharged; and nitrate of silver acquires a milky-white opacity; both solutions having been made with distilled water. An injection is thrown up the urethra by means of a small glass syringe; and so that it shall be applied only to the affected portion of the urethral tract, the finger is placed under the canal just in front of the scrotum. For deeper injection, as mostly in *gleet*, various forms of catheter-syringe have been devised, principally by Tiemann. Astringents in the form of powder can be injected to any particular part of the

urethra, by means of Mallez's breech-loading metallic tube; but such localised application will rarely be appropriate. Bougies, besmeared with an ointment of nitrate of silver, or the balsam of copaiba, may be passed along the urethra; but this mode of making topical applications is not in general use. In old-standing *gleet*, the introduction of a bougie occasionally, even where no stricture exists, is highly beneficial. It should be of sufficient size to occupy the urethra without distending the passage; be left in for about ten minutes at a time, and be passed twice or thrice a week. Blistering the penis, in obstinate gleet, has found favour with some Surgeons; the unguentum lyttæ spread on lint, is wrapped around the body of the organ, and applied for not longer than two hours. The effect is said to be singularly curative, when the gleet discharge is uncomplicated by stricture or orchitis.

The medicinal treatment of chronic suppurative discharge, and of watery gleet, is best fulfilled by an acid-tonic mixture of cinchona with sulphuric acid; but towards the close of the case, the sulphate of iron should be given, to repair the anæmic condition. Such treatment as may be suitable in the various other constitutional conditions, must not be overlooked; as in the scrofulous, rheumatic or gouty diathesis, on which a gleet discharge may depend. Certain medicinal agents have apparently a *specific* influence in arresting the discharge, and especially the two renowned specifics—copaiba and cubebs. Some surgeons urge the employment of these medicines in the acute stage of gonorrhœa. Neither should be administered when it

manifestly disagrees with the patient ; nor continued on trial beyond a week or ten days, when no beneficial effect has been obtained by that time. Both these specifics are apt to disturb the digestive organs, and produce symptoms of renal irritation ; and copaiba sometimes induces a cutaneous rash, in the form of small red patches, more or less circular, somewhat like nettle-rash. But the various *preparations* of these medicines are not equally to be commended. Copaiba may be given in capsule, pill, or draught. The capsule, an envelope or coating of gelatine, containing a small bolus of copaiba, is an elegant and convenient preparation ; the envelope disguising the nauseous taste and peculiar odour of the balsam. Six or eight capsules may be taken daily. The French dragées are also much used, particularly in America. In the form of pill, consolidated with magnesia, copaiba sometimes acts more effectually, a drachm being taken thrice daily ; or combined with dilute sulphuric acid, fifteen minims, and mucilage in infusion of roses, as a mixture, this medicinal agent is better tolerated by the stomach. Cubebs may agree when copaiba will not. The dose of the powder is a drachm, three times a day. Both specifics are sometimes advantageously taken together, in such proportions as to form the consistence of an electuary ; of which a drachm will be the dose, thrice daily. I never find it necessary to prescribe either copaiba or cubebs, and have for some years discarded them. In concluding the treatment of gonorrhoea, hygienic resources may prove singularly beneficial. The tepid or cold sponge-bath, with friction

afterwards, sea-bathing, an open-air life, avoiding horse-exercise, will often succeed in finishing off an otherwise lingering case. Smoking should be prohibited. As any persistent urethral discharge might be contagious, sexual intercourse must be strictly forbidden.

Chordee is best prevented or overcome by a nightly pill of opium and camphor,—say i gr. to ii grs., as an anodyne antispasmodic, or conium and camphor in pill, I have often ordered with marked relief. Camphor alone may be taken, as Mr Milton directs; one drachm of the tincture in water, before going to bed, and repeated every time the patient wakes with chordee. Or Ricord's suppository,—of opium, the watery extract, gr. i, with camphor grs. x, may be introduced into the rectum an hour before bedtime. The patient must deny himself supper or any excitement before going to bed, and then bathe the parts with cold water, or better, with hot water until a sensation of faintness is produced; he should lie on a hard mattress, and be lightly covered with bed-clothes.

Gonorrhœal *epididymitis* and *orchitis* may be treated by rest in the recumbent position, warm fomentations, and leeches if necessary; but sedative measures, especially hyoscyamus in full doses, with camphor mixture, will often prove sufficient to subdue the pain and swelling of the testicle; while, if the urethral discharge has been suddenly suppressed, I am in the habit of soliciting its return by enveloping the penis in a poultice.

Gonorrhœa in the Female is a much less common affection than in the male sex. But the inflammation

and discharge is rarely restricted to the urethra ; the vagina is the chief seat of gonorrhœa. The symptoms are heat and itching in the vagina, with scalding in the urethra when the urine is passed ; on examination, the vaginal passage is found to be red and swollen ; these early symptoms being soon followed by a copious, greenish yellow, muco-purulent discharge, proceeding more especially from the upper wall of the vagina. The labia may become involved, appearing red and puffed, while the secretion from the sebaceous follicles gives an offensive character to the discharge. Sometimes the inflammation extends backwards to the os uteri, which presents small patches of superficial ulceration. But all the symptoms are usually milder than in the male ; and although perhaps of longer duration, the discharge does not generally pass into gleet. Simple vaginitis must not be mistaken for gonorrhœa ; and yet their *diagnosis* cannot be determined by any one symptom, or by the combination of symptoms, nor by the appearance of the discharge or its inspection with the microscope. This absence of any distinctive evidence is a very important consideration in relation to medico-legal inquiry respecting supposed gonorrhœa in young females and children ; who are very liable to simple inflammation of the vagina from various causes, both constitutional and local. The diagnosis is scarcely less doubtful with regard to vaginal uterine discharges at any period of life.

Fewer untoward events are likely to *complicate* the course of the disease in women than in men. Not

unfrequently one of the swollen labia suppurates, the abscess pointing on the inner side. There may be some inguinal sympathetic bubo, but almost only in cases where the urethra is affected; and sometimes the vaginal inflammation creeps up into the cavity of the uterus, and may even pass up the Fallopian tubes to the ovaries; the ovaritis thus induced corresponding to epididymitis in the male. Gonorrhœal rheumatism is a rare occurrence, and gonorrhœal ophthalmia is seldom met with.

Treatment may be comprised in a few words. No special remedial measures are requisite, but the topical applications must be made directly to the part affected. Thus, injections must be thrown up the vagina so as to reach the seat of inflammation, and lotions should be applied by means of a fold of lint placed well in between the labia.

STRICTURE OF THE URETHRA.—Among diseases of the Urethra, Stricture justly ranks high in its importance; whether on account of its frequency, the distress it occasions, its serious and fatal consequences when neglected, or the unquestionable means for cure or relief.

The term Stricture of the Urethra signifies an unnatural narrowing or contraction of this passage, at one or more points in its extent. This may depend on either of three distinct conditions:—(1) Lymph-deposit in the mucous and mucous tissues, as the result of chronic inflammation,—and thence known as Organic or Permanent Stricture; (2) Spasmodic contraction of the muscular fibres encircling the mucous membrane,—

Spasmodic Stricture; (3) Inflammatory congestion of the mucous membrane,—Inflammatory Stricture. The two latter conditions of stricture—spasm and inflammation, often coexist; and either may be engrafted for a time, on organic stricture.

ORGANIC OR PERMANENT STRICTURE.—Four forms of organic stricture of the urethra may be recognised, according to Sir H. Thompson's accurate observations:—*linear* stricture, in which the urethral canal is obstructed by a thin, membranous septum, having a central aperture; or a crescentic septum, which obstructs a segment only of the calibre of the canal; the forming the "bridle stricture;"—*annular* stricture, a thicker and broader, contracted portion of the urethral canal, as if a piece of cord had been tied around it at one point, leaving the remainder free;—*indurated annular* stricture, a more confirmed contraction, in which the induration involves the tissues of the urethra to the depth of half a line or a line, it is limited in length from before backwards to less than half an inch of the canal, and forms an hour-glass contraction, usually thicker on the floor than at the upper aspect of the urethra;—*tortuous* or irregular stricture, owing apparently to adhesion of the rugæ of the urethra, to a short extent, or to a cicatricial patch of induration, or a longitudinal contraction and induration to an extent of one or more inches. In this condition of stricture, the induration may involve the entire substance of the corpus spongiosum, presenting the most obstinate and undilatable form of stricture.

Situation of Stricture.—The urethral canal is liable to stricture in three situations:—(1) At the junction of the spongy and membranous portions (Fig. 30), or within an inch before, and three-quarters of an inch behind, that point. Of these situations, the most common seat of stricture is the bulbous part of the spongy portion—anterior to the triangular ligament; rarely, behind this membrane, in the membranous portion, and most rarely as far back as the posterior part of the membranous portion. No instance has been found of stricture of the prostatic portion of the urethra. The above strictures correspond to the sub-pubic curvature.

(2) In the centre of the spongy portion, or that portion of the urethra which extends from the anterior limit of the preceding to within two inches and a half of the external meatus, a length of about three inches.

(3) At the external orifice, and within a distance of two inches and a half of it.

These definitions as to the situations of urethral stricture result from a laborious examination by Sir H. Thompson, of 270 preparations in our principal public museums, and comprising 320 distinct strictures. In region (1) were found 215, or 67 per cent. of the entire number; in region (2), 51, or 16 per cent.; in region (3), 54, or 17 per cent. Mr H. Smith made a similar investigation of this question, on a smaller scale; the preparations numbering 98, as preserved in the different London Museums. Of these, 77 were strictures situated anterior to the triangular ligament;

and 21 only, in the membranous portion of the urethra.

Several strictures may coexist in the same urethra; John Hunter records an instance of six strictures in one urethra; Lallemand and other French writers describe seven or eight; Sir H. Thompson has never been able to find any such examples, and he limits the highest number of coexisting strictures to three, or the most four. In the above number of 270 preparations, 8 were cases of stricture in all three regions; 10 in regions 1 and 2 only; 10 in regions 1 and 3 only; 13 in regions 2 and 3 only.

The urethral obstruction occasioned by stricture gives rise to *symptoms* which are individually, or collectively, significant of this condition. Increased frequency of micturition arises, owing to the inability to completely empty the bladder; the stream of urine becomes smaller than is natural to the individual, and altered in form, being either flattened, twisted or corkscrewed, forked, or turned aside; and discharged with a less forcible propulsion, so that the current is not ejected as far from the person as formerly, and at length issues as a mere dribbling or in drops.

As the obstruction *increases*, the muscular coat of the bladder gradually strengthens and hypertrophies, in order to compensate for the difficulty in ejecting the urine through the strictured urethra; and as this thickening of the bladder proceeds, its capacity is proportionably diminished, less urine can be retained, and micturition must be even more frequent. This state, annoying and inconvenient during the day, is

distressing at night, when exhaustion would invite to rest; the sufferer being repeatedly aroused from his temporary doze, and the night passed in restless efforts to obtain relief. After each act of micturition is apparently completed, another significant symptom is experienced; a certain portion of urine still escapes as a dribbling leakage, owing to the propulsive force of the remaining urine being insufficient to overcome the resistance of the stricture, which was dilated by the stream passing when the bladder was full. After the act of micturition is actually quite finished, a certain portion of urine can sometimes be squeezed out by pressure behind the seat of stricture, from the dilatation of the urethra in that situation. Pain is usually felt in the canal behind the stricture, during the effort to pass urine; and by constant straining, some feculent matter or flatus escapes at such times, and a tendency to prolapsus of the bowel is established. In a paroxysm of straining effort, rupture of the urethra may occur, behind the stricture; and then extravasation of urine takes place into the cellular texture of the perineum, scrotum, and supra-pubic region. In the act of coitus, much pain is experienced about the ejaculatory ducts; and, as the semen escapes with difficulty through the urethra but passes back into the bladder, there may be no seminal emission; and the unhappy patient believes himself actually, as he may be virtually impotent. The urine undergoes those changes which result from chronic cystitis, consequent on retention. It becomes ammoniacal, cloudy, and deposits more or less mucus and pus, with phosphates.

Hæmaturia is an occasional concomitant of stricture; the blood coming from the mucous membrane of the bladder, or perhaps from the urethra after catheterism or an erection of the penis affecting the seat of stricture. A gleet discharge not unfrequently attends old stricture of the urethra.

The general health fails, the patient losing flesh and strength; he has an anxious and careworn appearance, suffers from pains in the loins, lower part of the belly, the perineum and testicles; and is subject to severe attacks of rigors. Any irritation of the urethra, as by passing an instrument or the application of an irritant substance, will often provoke such an attack, especially in those who have lived in hot climates, or it not uncommonly excites general feverishness—hence named “urethral fever,” and which has sometimes an intermittent character.

Certain *varieties* of organic stricture may be recognised by some peculiarity of their respective symptoms.

Simple stricture; chiefly denoted by diminution in the size of the stream of urine, with the other ordinary symptoms of stricture.

Sensitive or *irritable* stricture.—Proneness to disturbance of the nervous system, as manifested by chilliness or rigors on very slight urethral irritation; and pain, sometimes persistent, from the gentlest passage of an instrument. A disposition to hæmorrhage is evinced in a few cases.

Contractile or *recurring* stricture—distinguished by a constant tendency to further diminution of the urethral

canal, in the absence of treatment; and contraction recurs rapidly after dilatation has been effected.

Examination of the Urethra.—Catheterism, or what I would term, bougieism—the use of a bougie, supplies the most direct and conclusive evidence as to the existence of stricture; evidence analogous to that of sounding for stone in the bladder. The presence of stricture, its situation, its calibre, the extent of the canal involved, and the amount of induration, may be thus severally determined; and whether also there be one or more strictures. Instruments of various composition and form are used for this purpose; *catheters*, which may be inflexible as the ordinary silver instrument, or flexible gum-catheters; and *bougies*, which are solid instruments of flexible metal, or flexible and more or less elastic, as the ordinary gum-elastic bougie, wax, or cat-gut bougies. Catheters may be curved or straight. The former shape is generally applicable; and the curve most commonly suitable, is that which corresponds most nearly with the bend of the urethra at its inner third—an arch rather less than one-fourth of the circumference of a circle $3\frac{1}{4}$ inches in diameter. Straight instruments are preferable for strictures in the ante-scrotal portion of the urethra. The *probe-pointed steel stricture-staff*, such as that used in perineal section, affords the surest indication as to the situation of stricture in the course of the urethra; the shoulder of the instrument being arrested by the constriction, its anterior limit is thus declared. At the same time, on passing the finger into the rectum, the narrow portion of the staff can be felt to have passed

through the stricture,—at the membranous urethra. The *bougie olivarie* possesses two advantages; a bulbous or spear-headed end, and flexibility; it can, therefore, be insinuated, or passed with a screw-like action, into a tight stricture, and readily takes the course of an irregular urethra—without causing a false passage, pain, hæmorrhage, spasm, or rigors. This instrument, invented by Lioult, and originally advocated by Mr Teevan, in this country, is now much used. The *bougie à boule*, having a conical-shaped extremity, is another flexible and elastic instrument of much use in the diagnosis of stricture.

The *introduction of a catheter* may be performed in either of two ways; in the recumbent position, and with the curve of the instrument directed upwards; or in a standing position, and with the curve of the instrument looking downwards. Of these two methods, the former is usually more easy and convenient both to the patient and Surgeon. The patient lying down on his back, with the shoulders a little raised, the legs thrown easily apart, and slightly drawn up; an instrument of appropriate size—number 7 or 8—is selected, and warmed by a little friction up the sleeve for a few seconds, and then oiled or smeared with lard. In introducing it, the handle should be held lightly between the thumb and the fore and middle fingers of the right hand—the concavity of the curve looking upwards towards the left groin of the patient, and the direction of the instrument being nearly horizontal. Raising the end of the penis with the thumb and finger of the left hand, so as to draw it up to its full length;

the double curve of the urethral passage, somewhat resembling an italic *S*, is thus changed into one curve, commencing from just in front of the scrotum; and this single curve corresponds to the curve of the instrument, as it passes along the urethra from that point downwards and upwards into the bladder. The point of the instrument—held as directed—is now inserted into the urethral meatus and carried slowly onwards along the floor of the canal—to avoid the lacunæ on its roof, until four or five inches have disappeared; the handle is brought, at the same time, to the middle line, but still parallel and near the patient's abdomen; then it should be gently raised, and as the point of the instrument passes under the sub-pubic curve, the handle is carried forwards and lightly depressed until it sinks below the horizontal line, when the opposite end will turn upwards into the bladder. After the point of the instrument has passed below the scrotum, its further progress in the right direction may be facilitated or maintained, by guiding it between the fore and middle fingers of the left hand, under the pubes; and sometimes, the introduction of the fore-finger into the rectum will aid in determining the middle line onwards to the bladder. That the bladder is entered is announced by some escape of urine through the catheter, on withdrawing the stylet, and by freedom of the point on attempting to rotate the instrument from side to side. But, no urine will escape, when there is only a small quantity, in the lower fundus of the bladder, and the patient recumbent; and, I have noticed, that, in the sitting or standing position, there

may be a small or dribbling stream, even when the bladder is nearly full, owing apparently to temporary atony or paralysis of the organ. After a few minutes, the urine may be drawn off freely, or discharged in a full stream. In passing a catheter, any slight resistance may be obviated by manipulating the instrument, in respect to its direction, or withdrawing it for an inch or so, and then re-passing it. But the presence of *stricture* is determined by an arrest of the instrument point blank, and at the same part of the urethra on each re-introduction. If, sometimes, the point of the instrument be only stuck in a lacuna or some fold of the mucous membrane, the point will feel loose, and should be disengaged; whereas, when it has entered fairly into the stricture, the point is felt to be grasped tight, and then it should be gently urged onwards. Remembering the situations of stricture, this obstruction will be found usually behind the scrotum, in the sub-pubic curvature; less frequently in the ante-scrotal portion of the urethra. No force should ever be used, nothing more than the pressure of a light hand, exercised slowly, continuously or intermittently, and with patience. Any departure from this injunction may lead to perforation of the urethra and the formation of a "false-passage;" and this misadventure is the more likely to happen while the handle of the instrument is being depressed, whereby the shaft acts as a powerful lever on the point in the urethral passage.

The other method of introducing a catheter—when the patient stands upright, is performed in the *opposite*

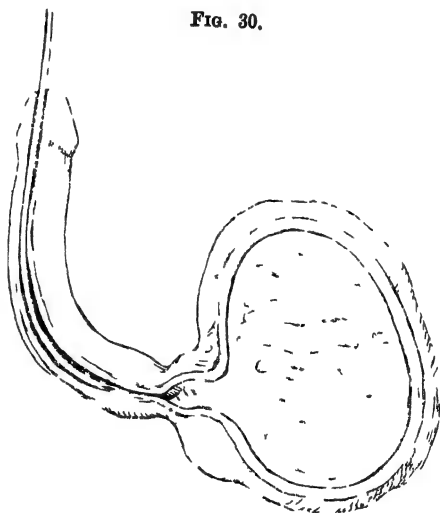
manner to that in the recumbent position. It is the "tour de maître" of French authors. The patient standing with his back to a wall, so that the nates shall not recede during the procedure, and with his legs a little apart; the instrument is introduced with the curve looking downwards, and the handle in a perpendicular line beneath, the penis being drawn straight forward. Having passed the instrument in this direction as far as the sub-pubic arch; it is swept round to the right and raised upon the abdomen, thus describing a semicircle, of which the catheter-point is the centre; then the handle is gradually depressed, so as to carry the point of the instrument through the sub-pubic curve into the bladder.

The *existence* of stricture having been ascertained by the obstruction offered, at some point, to the introduction of a catheter along the urethra; its *situation* may be estimated by feeling the end of the instrument behind the scrotum, or in front as the case may be, and noted more accurately by the length of the instrument passed from the external meatus (Fig. 30). The *degree* of contraction or the calibre of the canal at that point can be estimated by the size, or number, of the instrument used; the *extent* of the canal involved, by the length of the instrument "held" or "grasped" from the point of entering the narrowed portion of the urethra; while, at the same time, the amount of *induration* may be judged of by an experienced tact. A second or third stricture is discovered in like manner, by continuing the urethral examination.

To complete the examination of any one or more

strictures, several instruments, of different sizes, will perhaps be necessary. In the English scale of 12, the five sizes from 7 downwards, will generally be found most serviceable, for this purpose. The French scale possesses three advantages over the English scale; it commences with a smaller size,—1 milli-

FIG. 30.



(Liston.)

mètre, or $\frac{1}{8}$ inch, instead of 5 millimètres, and ascends by a series of smaller intervals between each number; the intervals are more regular; and the number of the catheter represents the calibre or size of the instrument,—No. 1 being 1 millimètre, No. 2 is 2 millimètres, and thence, by similar gradations, up to 30 millimètres. Nos. 3 to 21 about equal Nos. 1 to 12 English scale. Number 7, or 8 (English) size should always be tried first; a smaller sized instrument is

liable to hitch in one of the urethral lacunæ, or against the veru montanum, or in the sinus pocularis, as if it were fixed in the stricture; or it might pass through the stricture imperceptibly. Either occurrence would mislead the Surgeon. The smaller the instrument, the greater caution and delicacy must be observed in using it; lest incautiously the urethra be perforated. A soft *wax-bougie* has been recommended with the view of taking an impression or mould of the size and extent of the stricture. Any such supposed advantage is more than neutralized by the difficulty of finding the stricture, as compared with the facility in using an inflexible instrument.

The introduction of *bougies*—which are now much employed—require no special directions for their use.

Causes.—Two classes of causes may be recognised as resulting in the formation of an organic stricture.

(1) Inflammation of the urethra with *plastic deposit* in the mucous and sub-mucous tissues; thereby glueing together the organic muscular layer which immediately underlies the mucous membrane, and in virtue of which the canal naturally undergoes temporary alterations of calibre, by relaxation or contraction. This kind of cause comprises gonorrhœa; when the inflammation extends along the canal, and is of a severe or long-continued character. The symptoms of stricture supervene very slowly and insidiously; a period of many years perhaps elapsing before the existence of this organic constriction is declared. Simple urethritis may have the same result, but only under the operation of some persistent constitutional condition. Injections for the cure of

gonorrhœa tend to the formation of stricture; when used in the inflammatory stage, or of too great strength, or long continued. Thus, an injection of nitrate of silver, j to ij grs. to ℥j of water, can do no harm; but in the proportion of x grs. to ℥j, it may certainly produce stricture. Abscess in a lacuna of the urethra followed by contraction of the *cicatrix*, is an occasional cause; and cancerous or other ulcers may similarly result in the formation of stricture, usually near the external meatus; amputation of the penis sometimes issues in like manner.

(2) Injury to the urethra by external violence on the perineum, bruising, lacerating, or rupturing the urethra, is followed by a *cicatrix*, the contraction of which is very apt to result in stricture of the most severe and intractable character. This kind of cause comprises; kicks on the perineum, or falls on some hard projection, as across spars, scaffolding, ladders, chairs, saddles, gates, wheels, &c.; puncture of the perineum, by palisading, by an earthenware vessel breaking under the sitter, &c.; laceration, by pelvic fractures involving the urethra; and lastly, by the forcible introduction of urethral instruments.

Congenital stricture is occasionally met with, near the external meatus; in early life, its existence is unattended by any inconvenience; but in adult life, it gives rise to serious obstruction to the passage of urine, when the urethral tissue has become less extensible.

Consequences, and Terminations.—The course of stricture is very similar to that of chronic enlargement of the prostate. *Chronic* cystitis or a state of the

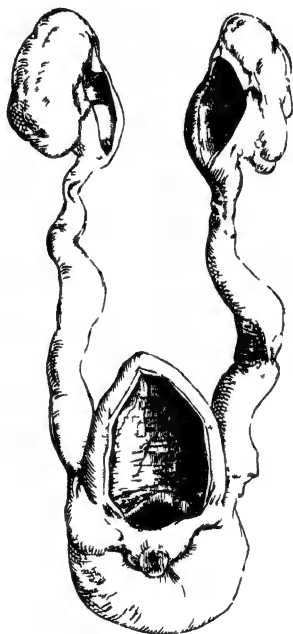
bladder bordering on it, commonly ensues from the habitual retention of urine and distension of the bladder. The characters of the *urine* are in accordance with that condition. The *general health gradually declines*; as the result of broken rest from ineffectually relieving the bladder, and of constitutional disturbance owing to the state of the organ, aggravated by occasional attacks of *spasmodic retention*; or the constitutional symptoms may be those of increasing *nervous prostration* with oft-repeated rigors, induced sometimes by each act of micturition, or simply by the use of an instrument; and *rapid depression* may supervene, either from ulceration or sloughing of the bladder with recurring hæmorrhage, or from profuse purulent discharge. *Rupture of the urethra* is liable to occur, owing to dilatation and ulcerative opening of the canal immediately behind the stricture; followed by *extravasation of urine* with its attendant symptoms. This may happen at a more or less remote period. I have known extravasation occur in traumatic stricture, twenty-six years after the injury, a fall on the perineum across a beam; and also in stricture from gonorrhœa, five years previously. Rupture of the *bladder* is a very rare event. Both these consequences of Stricture are dependent on Retention of Urine, and they will be noticed under the head of Extravasation of Urine. *Suppression of urine*, with uræmia, sometimes arises from slight urethral irritation; as by the introduction of an instrument only one size, or number, larger than that to which the patient is accustomed, or in consequence of a slight urethral abrasion, or from the mere passage of an instrument. Severe rigors and

suppression of urine are both far more apt to occur when disease of the kidneys exists, so that the one becomes a tolerably sure indication of the other; and the fatal issue is more rapid and inevitable.

Certain *pathological conditions* of the urethra, prostate, vesiculæ seminales, bladder, ureters, and kidneys, result from the mechanical effect of long-continued retention of urine. They are discovered, mostly, *after death*. The *urethra* is contracted in calibre before, and dilated sometimes into a sacculus just behind, the seat of stricture. In the latter, or dilated pouch, sabulous matter and even calcareous concretions, occasionally collect. Rupture of the urethra may have taken place in this dilated portion; and in connexion with an abscess, usually perineal. This abscess may have opened externally, as well as communicate with the urethra,—constituting a fistula in perineo, with perhaps several branch fistulous openings and surrounding consolidation. The ejaculatory ducts also, in the sinus pocularis, are enlarged. The *prostate* gland has been found converted into an abscess, multilocular, or as a single cavity, bounded by the fibrous capsule; and communicating by one or more ulcerated openings with the prostatic urethra. The *vesiculæ seminales* are then often distended with glairy and fetid purulent matter. The *bladder*, subjected to the constant backward pressure of urine, which distends its cavity, is fasciculated internally, and perhaps sacculated; the one alteration of this organ representing an hypertrophied state of its muscular bands, the other, intervening pouch-like protrusions of the mucous membrane. The general result is a

diminution in the capacity of the bladder for the retention of urine (Fig. 31), or, its total capacity may be thus much increased. Rupture of this organ may have happened, though very rarely. Sometimes, it takes

FIG. 31.



(Liston.)

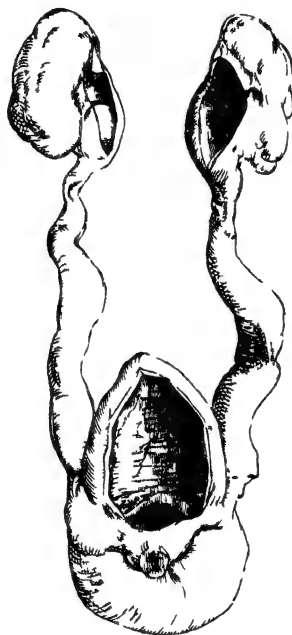
place in consequence of a small pin-hole aperture of ulceration in the mucous membrane of one of the sacculi. The *ureters* have undergone dilatation by the tendency to reflux of urine, and the pelvis of these tubes may thus be found much enlarged; while the *kidneys* are more or less degenerated and atrophied

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in their pyramidal and cortical portions, resulting perhaps in sacculated remnant kidneys, or in the formation of mere bags, or cysts. Sometimes these organs are beset with multiple abscesses, as the result of pyelitis or nephritis from the backward irritation of prolonged retention. Hence, the suppression of urinary secretion, with uræmic blood-poisoning.

Treatment.—The object of treatment is two-fold ; to restore the urethral canal to its natural calibre, and to maintain that state of patency. But for the accomplishment of this object, different modes of treatment are necessary according to the various states of stricture ; its degree of contraction, and induration or dilatability, its sensitiveness and proneness to disturbance of the nervous system, its contractility and disposition to return. All the modes of treatment may be reduced to four ; (1) Gradual Mechanical Dilatation ; (2) Immediate and Forcible Dilatation, or Rupture ; (3) Caustics ; (4) Division of the Stricture, either by internal urethrotomy, or by external urethrotomy,—usually perineal section.

GRADUAL MECHANICAL DILATATION,—inducing absorption of the plastic deposit around the seat of stricture. This method of treatment is most generally applicable ; the other methods being resorted to when it proves ineffective, or when it is contra-indicated by one of the adverse states of stricture above mentioned.

The *instruments* used for gradual dilatation are catheters and bougies,—inflexible, or flexible and elastic ; and always of gradually increasing size.

The selection of an appropriate instrument, in respect

to its material, terminal shape, size, and curve—if an inflexible instrument, will depend on the degree of contraction and the situation of the stricture; both these points have been determined by urethral exploration with a catheter, or bougie, as already explained in completing the diagnosis of stricture. A *catheter* is generally preferable for *that* purpose; as not unfrequently the patient first seeks relief when suffering from an attack of retention, and the Surgeon having succeeded in getting an instrument into the bladder, may be very glad to leave it there. Hence, also, a catheter is generally most suitable in the *commencement* of treatment.

The introduction of a *catheter* may be performed in either of the two ways already described; and according to the directions given. An instrument of such *size* only should be used as shall be found to enter the stricture easily, and can pass fairly through it without feeling tightly held by the contraction. Dilatation is then effected by leaving the instrument in this contracted portion of the canal; so as to continue the slight expansion, and induce absorption of the plastic deposit in the mucous and sub-mucous tissues forming the stricture. The proper *period* for maintaining the dilatation is, in my judgment, about five minutes,—some say twenty minutes; then* the instrument should be withdrawn, and its size, or number, noted, as a standard of comparison in the subsequent introduction of gradually larger-sized instruments. Prof. Spence's three recommendations are, I am sure, here advisable:—always pass the size of instrument used on the previous

occasion, before proceeding to the next larger size ; never omit any one size to pass a higher one ; never pass two larger sizes on the same occasion. By disregarding either of the two latter rules, undue irritation will almost certainly be excited, and the surgeon is more likely to lose than gain ground. An instrument may be *reintroduced* every two or three days. But the intervals of catheterization must be regulated by the state of the urethra, and the constitutional disturbance induced. When bleeding, pain or smarting in micturition, follow or continue after the operation—events very likely to happen after the first passage of an instrument through the stricture ; further dilatation must be postponed for a day or two, until this urethral condition has subsided. Rigor or shivering, faintness, or sickness, may also supervene, especially under similar circumstances ; postponing any reintroduction of an instrument until this state of constitutional disturbance has passed off. Chloroform, therefore, often becomes an invaluable agent in the treatment of tight stricture by dilatation. Spence is inclined to believe that rigor arises from the irritation produced by the instrument in passing over the prostatic urethra and neck of the bladder ; hence, in using the smaller sized instruments, when the flow of urine shows that the bladder is entered, the catheter should be withdrawn, and left only in the stricture ; or in using those of larger size, the instrument is passed only through the stricture, and no farther.

Flexible and Elastic Bougies are now much employed as a substitute for catheters,—metallic or gum-elastic,

in the treatment of stricture by dilatation, as well as in the diagnosis of stricture. These instruments owe their advantage not only to their flexible and elastic character, but also to the peculiar shapes of their distal extremities. The forms more commonly employed are:—the *bougie olivaire* having an olive-bulb-end, whereby the instrument can be insinuated or twirled into a stricture, aided by the flexible nature of the shaft, without the liability of making a false passage; the *bougie conique*, having a conical capering point, can enter a stricture more readily, or even of tighter contraction, but it is liable to lodge in a lacuna, and make a false passage, which is prevented by the olive; the *bougie olivaire à ventre*, having a spindle-shaped enlargement above the olive end, thus specially dilates the stricture, and up to the largest-sized catheter, without painfully distending the comparatively narrow external meatus of the urethra; the *bougie conique à ventre*, is similar to the last, and used for a similar purpose, but its conical end has some disadvantage relative to the formation of false passage. The *bougie à trois nœuds*, having three conical enlargements, of successively increasing size, this instrument is specially suitable for rapid dilatation.

For very tight strictures; the *filiform elastic* bougie may be twisted through the urethra, inch by inch from the glans, any obstruction being indicated by the shaft of the bougie springing back, until it is arrested and held in the stricture. The *olivary whalebone* bougie, though almost filiform, is much stiffer, yet being provided with an olive end is safe in its passage; this

instrument thus seems specially suited for very tight, indurated, and perhaps extensive stricture, as when of traumatic origin. Elastic instruments were originally introduced into surgery by Bernard a French goldsmith, who brought them before the Academy in 1779. Recently they have come into general use in America; and in this country, principally by the advocacy of Mr Teevan.

This plan of treatment—by gradual dilatation, must be prolonged until the urethral canal is restored to its natural size, and the stream of urine fully established. The urethra may then admit a catheter of full size,—number 12, or a bougie of equal size, with ease; when it should be passed less frequently, once in a week or ten days. Lastly, it will be necessary to maintain the patency of the canal, by an occasional use of the instrument once in a month or six weeks.

In the course of treatment by dilatation, the general health should be attended to; especially with regard to the digestive organs, and the state of the skin and kidneys.

Continuous dilatation may be advantageously resorted to when the stricture proves *obstinate* under the ordinary plan of gradual dilatation. The principle is that of rapid dilatation and dissolution of the stricture, by retaining the instrument in the contracted portion of the canal for a period varying from forty-eight to seventy-two hours, at a time. The catheter is fastened by means of tapes passed through the eyes of the instrument, on either side, and thence under the buttocks and over the thighs to a waist-band. If a gum-

catheter be used, it can be secured by a strip of adhesive plaster to the penis. A peg of wood or bit of cork is inserted into the orifice of the catheter, and the water drawn off as occasion requires.

In the management of this process, three points must be observed:—the catheter should occupy the stricture, without fitting tightly or being grasped by it; the instrument, when tied in, should not project against the interior of the bladder; and after using a silver instrument on the first occasion, the succeeding instrument may be gum-elastic, as causing less irritation.

When, in about forty-eight hours, the catheter has become loosened in the stricture, and a slight purulent discharge has taken place around the instrument; it should be withdrawn. In two or three days, this procedure is renewed, and an instrument larger by two or three sizes may be at once introduced; and so on until a full-sized one can be passed easily. Recontraction must then be prevented by occasionally passing an instrument, at gradually increasing intervals of time.

Difficulties and Accidents in Catheterism.—*Induration* or hardening of the stricture sometimes presents considerable difficulty to insertion of the point of the instrument. This may perhaps be overcome by using a conical-shape pointed catheter, or bougie. But, if the stricture be not very sensitive, continued pressure on the face of the induration will probably cause the stricture to yield. Injecting the urethra with four or five drachms of olive oil seems to exercise an hydraulic pressure on the stricture by penetration of the fluid

into the narrowed passage. *Spasmodic* action must be overcome by the means appropriate for spasmodic stricture.

False passage.—A false passage, or a passage leading out of the natural urethral canal, is made by forcible and misdirected pressure with the point of any instrument in its course through the urethra. The passage, therefore, usually takes a direction downwards and backwards, and to one side of the urethral passage; in an opposite direction to the stream of urine, the free discharge of which remains unaffected. An inflexible instrument, as the ordinary silver catheter, will be more apt to cause this misadventure than a flexible instrument; but the latter is more liable to enter a false passage already existing.

The previous existence of such a passage or passages is perhaps the most common and perplexing occasion of difficulty in using an instrument; and its production, an accident most to be avoided. The importance of these considerations in relation to catheterism, lies in the fact that the difficulty of entering the right opening, is increased by the facility with which the instrument slips into the wrong one.

A false passage varies in its *situation* and *extent*. When the stricture is far forwards, the passage may run in the corpus spongiosum; when further backwards, in the usual situation, the passage may perforate the lateral lobe of the prostate or run up between it and the rectum; this latter direction being especially dangerous. The *floor* of the urethra is most commonly the seat of a false passage; and it is most liable

to happen in connection with a tight stricture, and the introduction of a small-sized instrument. Hence, in the treatment of such a stricture more particularly, and when it has been subjected to the previous use of instruments, an important practical injunction in passing the catheter is this,—the point of the instrument should be kept against the roof or *upper surface* of the urethral canal.

Certain *signs* at once indicate to the Surgeon that a false passage has been commenced, or entered if pre-existing. The point of the instrument is felt to make a sudden slip, and the shaft inclines to one side of the urethra; the point also feels free and moveable, and communicates a rough or grating sensation, while it can be easily withdrawn; all these peculiarities being more notable when occurring after the instrument had been felt to be held or grasped by the stricture. The patient experiences sudden and severe pain, and is often conscious that something has given way; on withdrawing the instrument, it is found besmeared with blood, and there will be free hæmorrhage from the urethra, with perhaps, I have noticed, some degree of turgid priapism. But an *old* false passage, with consolidated walls, will communicate the same sensation as if the instrument were passing through a stricture, and is unattended with pain or hæmorrhage; the only obvious sign perhaps being some deviation from the natural direction in the course of the urethra.

To avoid accidentally dilating a false passage, instead of the urethra, it has been proposed to pre-occupy that

passage with a fine probe-pointed whalebone bougie, before using the urethral bougie ; a practice chiefly in vogue among continental surgeons. One of the fine bougies is slid along the urethra, and if it slip into a false passage, it is left there ; a second and a third such passage may perchance be pre-occupied in like manner ; then, the urethral bougie can be thus guided almost with certainty into and through the stricture. This resource would seem to be appropriate only in the dilatation of a tight stricture, and when the false passages are not more in number than for the urethral canal to accomodate the fine bougies as well as the dilating instrument ; and in thus taking possession of existing false passages, care must be taken not to make fresh ones !

Hæmorrhage must be regarded as another accident attending catheterism ; but it is also liable to occur independently of any urethral lesion, from the mere passage of an instrument, in inflammatory stricture.

Inflammation affecting the urethra or testes may be induced by dilatation ; especially with instruments of too large a size, or rapidly increased.

Other evil concomitants, or consequences, have already been alluded to ; pain in micturition, rigors, faintness, sickness.

Gradual dilatation having proved ineffective for the cure of stricture, other methods of treatment must be resorted to ; and they are especially applicable, when either the sensitive state of the stricture or its contractile and recurring tendency would render that mode of treatment inapplicable, as being intolerable or un-

successful. The degree of *tightness* of the stricture and the amount of *induration*—together representing an undilatable state of stricture, will be found to determine the particular mode of treatment then appropriate;—whether Forcible Dilatation or Rupture, or Division by incision, internally or externally.

IMMEDIATE AND FORCIBLE DILATATION, OR RUPTURE.—In estimating the applicability, and advantage, of this method of treatment for stricture of the urethra; it would certainly appear that the vital character and constitutional relations of the urethral tube should forbid any dilatation of an immediate and forcible character; and still more so any rupture of its component tissues. Yet experience has now shown that not only may this mode of treatment be practised with impunity; but, that a tight stricture undilatable gradually, beyond a certain degree, and any further distension of which would excite severe constitutional disturbance, can be forcibly dilated or ruptured up to the natural size of the urethra and without producing any such symptoms.

Forcible dilatation is effected by means of *distending instruments*, which when passed through the stricture exert an expanding force from within outwards. Such force may be accomplished by a *series* of instruments, consisting of sliding tubes, passed successively over a slender urethral director or guide, which is first passed through the stricture; or, it can be effected by means of a *single* instrument which expands *in situ*.

Sliding tubes were originally employed by Desault (1797), and afterwards by Dr Buchanan of Glasgow

(1831), Dr Hutton of Dublin (1835), and by Maisonneuve (1845). Mr. Thomas Wakley, of the Royal Free Hospital, with whom this mode of treatment was originally identified in this country, contrived a series of accurately-fitting tubes and an urethral director. This having been first passed through the stricture, each sliding-tube, in succession, cannot fail to take the same course. The difficulty, and the risk, will always be to first introduce the slender director through a tight stricture; a difficulty proportionate to the degree of contraction, and the existence of false passages, or the liability of making them. *Single* instruments of various kinds have been devised, which expand *in situ*, in the place of several instruments of increasing calibre; and thus save the necessity of passing them successively through the constricted part of the urethra. With this object, Mr Luxmore (1812) employed diverging metal rods; Leroy d'Etiolles, the same method, some years later, and Perrève a somewhat similar plan (1847). Dr Neil Arnott, on the same principle, commenced the employment of fluid expansion (1819). Both these forms of contrivance,—the series of sliding-tubes and the single expanding instruments, have a similar action upon the urethra,—distension of the contracted portion from *within* its area. They thus differ from the large conical metallic bougie formerly used for the purpose of forcible dilatation, which was driven into the stricture; thereby running the risk of pushing the stricture down the canal and detaching its connections, and inevitably inducing inflammation and severe constitutional disturbance.

Rupture or Splitting of the Urethra.—Mr Holt has recently revived this mode of forcibly opening stricture of the urethra. It seems to be most applicable to tight stricture, *without* much induration; so that the plastic deposit does not form a mass too thick or dense to be entirely ruptured. Rupture may, therefore, possibly supersede the necessity for division by a cutting operation.

The “dilator” used by Mr Holt is precisely similar to that of Perrève. Its construction, and his mode of operating, he thus describes:—The instrument consists of two grooved blades fixed in a divided handle, and containing between them a wire welded to their united point; on this wire a tube—which when introduced between the blades corresponds to the natural calibre of the urethra—is quickly passed, and thus ruptures or splits the obstruction. Having introduced the instrument, and reached the bladder, it should be gently rotated, to prove that the end is fairly within that viscus; and being thus assured, the Surgeon is next to place the point of the tube he had previously selected, upon the wire between the blades, and thrust it quickly onwards to the end. The stricture being now fairly split the dilator should be rotated, to still further separate the sides of the rent, and then be withdrawn; a catheter, corresponding to the number of the tube, being substituted for the purpose of removing the urine. The catheter is then withdrawn, the patient treated with quinine and opium for the first twenty-four hours; and the same catheter introduced occasionally perhaps during that period, to

prevent any risk of urinary infiltration in micturition ; or in forty-eight hours, to maintain dilatation ; and again on alternate days for a week or two, gradually lengthening the interval. Voillemier's instrument differs from Holt's, in an important particular ; the tube is provided with lateral grooves, so as to slide along the blades, instead of upon a central wire-conductor ; the expanded instrument thus assumes a circular instead of an oval form, whereby the dilating force is expended *equally* upon the whole circumference of the urethral canal.

The *results* of this procedure in the hands of Mr Holt have been eminently successful ; and the experience of some other Surgeons has confirmed its value. I have not seen much constitutional disturbance follow the operation of splitting the urethra ; but in one case, operated on in another Hospital, extravasation of urine ensued, for which I treated the patient at the Royal Free Hospital, and he recovered. Many deaths, however, have I believe occurred,—Mr Teevan says fifteen in number, which have not been included in the Reports of Cases hitherto published. It would also be very desirable to diagnose more correctly the *pathological conditions* of stricture submitted to operation,—if indeed they can always be determined clinically ; since it will be obvious that the mere splitting up a number, say some scores, of urethræ, many of which were perhaps scarcely strictured at all, can have nothing to do with the propriety or eligibility of this mode of treatment. The splitting of urethræ in almost a *healthy* state, would necessarily swell the

resultant proportion of, apparently, successful cases. I do not apply this remark to Mr Holt's cases, but to an extraordinary large series which has been published.

Sir H. Thompson has contrived a screw-*distending* instrument for this operation, which seems to possess three advantages:—distension of the stricture *alone* is accomplished, without involving the healthy portion of the urethra in its action; the distension, as indicated by the scale near the handle, can be carried to a calibre of 14 or 16 of the catheter scale, beyond the size which the external meatus will admit, and is thus more efficient; and the distending force is applied very slowly, continuing from seven to ten minutes before reaching the maximum point of distension,—the object being to overstretch the morbid tissues as much, and to rupture them as little, as possible, in order to destroy, or greatly impair, the natural tendency of the stricture to undergo contraction.

Another screw-distending instrument, devised by Dr J. Thebaud, of New York, is worthy of notice. The terminal portion consists of two blades, which can be separated to such an extent as to rupture the stricture. Distension, or rupture, as thus effected, involves more than the constricted part of the canal;—a disadvantage compared with Thompson's instrument; while,—relative to Holt's dilator, Thebaud's instrument has the disadvantage of being too large-pointed for tight strictures, but the special advantage of carrying distension to any known *degree* is supplied by the index near the handle.

Strictures of *very* tight character may be penetrated

by a filiform bougie guide, adapted to the end of any such instruments; an addition originated by Van Buren, and completed by Charrière.

CAUSTICS.—Cauterization, in the treatment of stricture, has been practised with two objects in view; the deadening of sensibility or spasm, and the destruction of induration; in both ways permitting subsequent recourse to dilatation. For the former purpose, cauterization may be of some use. It can be effected by the introduction of an instrument armed with caustic, such as nitrate of silver or potassa fusa, which is carried down to, and allowed to rest against, the stricture, for two or three minutes. A gleet discharge is thus established, and the caustic reapplied every two or three days until a catheter or bougie can be passed, and gradual dilatation made to complete the cure.

This method of treatment was formerly in vogue, and still, I believe, has one or two advocates in this country, principally the late Mr Wade, and less urged by Mr H. Smith; but the experience of the best Surgeons both here and in France has condemned it, as being both perilous, and extremely uncertain in its results. Stigmatised by Mr Liston, as "most atrocious," and discountenanced more recently by Nélaton; the cure of stricture can always be accomplished more safely, and with greater probability of non-recurrence, not to mention the liability of making a false passage. Cauterization has, therefore, now fallen into general disuse.

DIVISION OF THE STRICTURE.—Section of the urethra

may be appropriately resorted to in tight stricture, with considerable induration, forming a hard and large *nodule*, unfitted for rupture; and accompanied perhaps with much sensitiveness and irritability, or contractility and resiliency,—conditions which are also unfitted for gradual dilatation. The incision is made; either from within the urethra; or from without, and usually in the perineum.

(1) *Internal Urethrotomy*.—Division of the stricture from within the urethra has, been practised for above a century. Allies of France (1755); Physick of Philadelphia (1795), John Bell (1806), and his brother Charles Bell (1807), M'Ghie (1823), and Stafford (1827); have severally advocated this method of treatment. It has been practised extensively in France, especially by Civiale; and less frequently by modern surgeons in America and in this country.

The operation may be performed in two ways;—*incision from before backwards*,—section being made by pushing downwards a lancet-like blade, generally with a slender conductor in advance of it, into the obstruction to be divided; *incision from behind forwards*,—a portion of the instrument containing a small blade, sheathed, is first carried down through the stricture, which is then divided by protruding the blade downwards and withdrawing it, in the floor of the urethra, through the whole of the contracted portion, with a little of the sound urethra in front and behind, but taking care not to incise too freely in depth. Thus, the length of this incision may be from one to two inches, while its depth should not exceed more than

half that to which the blade can be projected in Civiale's instrument. The penis should be stretched to steady the otherwise movable urethra. Of the two methods of operation; the former is suitable for anti-bulbous strictures, the urethra being straight in that portion of its course, is not liable to perforation; deeper strictures, situated in the curve of the canal, had better be incised from behind forwards. Various instruments, or *urethrotomes*, have been constructed for the internal division of strictured urethra. For incision from before backwards; Stafford's lancet-catheter may be used; the point is concealed in the tube until the end of the instrument rests upon the stricture, it is then projected and the instrument carried on through the obstruction. A curved, as well as the straight form of this instrument, has been employed. Sir H. Thompson's catheter-urethrotome, or Mr John Wood's instrument, are more applicable; also the urethrotome with terminal fine bougie guide, devised by Maisonneuve, or the similar shielded instrument of Voilemier. For incision from behind forwards, Civiale's urethrotome is the best form of instrument. Trélat's urethrotome can be used in both ways,—from before backwards, and then from behind forwards; thus making a second incision when necessary, and the operation more complete.* After either mode of operation, a full-sized catheter should be introduced, along the roof of the urethra to avoid the incision, and retained for twenty-four hours; although some Surgeons of experience think the latter practice unnecessary or objectionable. An instrument should

also be passed occasionally, for some time, to prevent re-contraction. A urethrotome provided with a terminal filiform bougie, will enable the operator to deal with *very* tight strictures.

The immediate effects, and after-consequences of internal urethrotomy are very seldom serious. Hæmorrhage, beyond a few drops of blood, is rare, and easily stopped by passing a full-sized instrument, and the application of ice externally. Some feverishness often ensues, but soon subsides. Abscess, and extravasation of urine are very uncommon, having taken place once or twice only in nearly 200 cases operated on by Sir H. Thompson; while, cystitis, nephritis, and pyæmia, are unknown.

The *results* of internal urethrotomy are also satisfactory, as regards the immediate restoration of the urethral canal to its natural calibre; the ultimate result may be permanent, or evince a tendency to the return of stricture,—generally, however, amenable to dilatation. It should also be observed that in both modes of internal urethrotomy, the strictured portion of the canal is usually already sufficiently large to admit an instrument, equal in size to a number 4 or 5 catheter; and that with this degree of patency, it may well be considered probable that further and perhaps complete enlargement might be accomplished by dilatation. I very rarely find it necessary to have recourse to internal section of the urethra. But the operation is at least a safe procedure; only one death having occurred in the above series of 200 cases.

(2) *External Urethrotomy*.—Division of the stricture by external incision is an alternative operation of

urethrotomy, the earliest instance of which for the cure of stricture, is recorded by Wiseman (1652). A few years afterwards, Solingen, at Livourne, adopted this procedure ; followed by François Tolet and Colet (1690). J. A. Petit, and Ledran (1740), had recourse to a similar operation ; and John Hunter (1783), performed the operation now known as the perineal section ; but it was rarely employed until advocated by Mr Grainger of Birmingham (1815), and afterwards by Mr Arnott. These operations refer to cases in which no instrument could be passed through the stricture. More recently (1844), Mr Syme has advocated external division of the stricture in cases where, although a catheter can be passed, no other treatment has afforded sufficient or permanent relief.

Perineal section, as the operation of external division of the stricture may be generally designated, is applicable in two degrees of extreme urethral contraction :— permeable stricture, through which a slender grooved staff can be passed, and the external incision made upon this instrument ; and impermeable stricture, through which no instrument apparently can be passed, the only guide being a full-sized instrument passed down to the stricture, towards the point of which the external incision is directed.

The condition of stricture appropriate for perineal section, is that of considerable, even cartilaginous, induration, both in *thickness* and *extent*, appreciable usually by external examination with the finger ; coupled perhaps with perineal fistulæ, either chronic or numerous.

(a) *Permeable Stricture*.—Perineal section, by Syme's operation, is performed as follows:—The instruments required are; a staff, slender, slightly curved, with a median groove in its lower half, and the upper of full size, a pointed scalpel, a broad director, and a silver catheter, number 8, or 10. The staff is passed *through* the stricture, so that the shoulder or termination of the upper thick portion rests against the upper part or face of the stricture. The patient is tied up as for lithotomy, and the staff held in like manner by an assistant, with the scrotum drawn forwards. The Surgeon, sitting in front, makes an incision in the raphé or median line of the perineum, about two inches in extent, and proceeds cautiously straight to the shoulder of the staff; feeling his way with the forefinger of the left hand. Having clearly reached that point, he takes the staff from the assistant in his left hand, and enters the point of the knife in its groove, *behind* the stricture; thence cutting upwards to the shoulder of the instrument until it can be passed onwards into the bladder. This instrument is then withdrawn, and the number 8 catheter introduced and retained for forty-eight hours. Subsequently a full-sized catheter should be passed every three or four days, and afterwards at longer intervals, to prevent re-contraction. Difficulty in introducing the catheter, after withdrawing the staff, may be obviated by first passing the director into the urethral wound, along which, as a guide, the catheter glides into the bladder. Instead of using a catheter, Mr Syme prefers at first to pass a tube through the wound into the bladder, in

order to guard the wound as much as possible from contact with urine. Hæmorrhage rarely proves troublesome immediately after the operation, or subsequently; and it can be stopped by careful plugging of the wound, then placing a compress over it, and retaining the whole in position by a T bandage,—a catheter being kept in the bladder.

The following directions are given by Mr Syme, as essential to the success of this operation:—1. Maintain the median line in the incisions. 2. Make a direct opening down to the staff, not a tortuous one. 3. Divide the whole of the contracted part, rather more than less. 4. Do not cut so far back as to endanger the deep fascia of the perineum, and use the knife in the deep incisions with the cutting-edge uppermost. 5. Do not close the end of the inlying catheter, lest urine be forced into or through the wound, for want of patency in the instrument. 6. Avoid escape or displacement of the instrument. 7. If incisions are made far back, introduce a curved tube through the wound when the catheter is withdrawn. 8. Do not neglect dilatation during the progress of recovery.

(b) *Impermeable Stricture*.—This condition of stricture is very rare, if it ever exists. As Syme justly observes, any stricture through which urine can escape, will admit an instrument to be passed with care and patience. Then, of course, the operation may be performed as for permeable stricture. Otherwise, a catheter of full size, having been passed down to the stricture, and held there firmly by an assistant, perineal section is performed; the point of the instrument being

the guide to, but not through, the stricture. Having clearly reached that point, the Surgeon endeavours to pass a small grooved director through, or partly through, the stricture ; and on this instrument he at once divides, or successively pursues, the tract of the contracted canal. When no director, however small, can be introduced, the urethral canal must be followed without any such guide, by dissection alone cautiously conducted. In either case, as soon as the continuity of the passage is restored, the catheter above is to be carried on into the bladder, and retained in the usual manner for a period of some days.

Results of Perineal Section.—The latter operation of external incision,—without an urethral guide, is of course hazardous and uncertain in its results. But external incision, as performed on a grooved staff, has yielded excellent results,—in an appropriate condition of stricture, and when the operation has been properly performed. Among 219 cases of this operation, collected with scrupulous care by Sir H. Thompson, there was a mortality of between 6 and 7 per cent. Of this percentage, nearly two-thirds died of pyæmia, the remainder, one or two only excepted, from fever and suppression of urine. Such a mortality is not large, considering the extreme cases of stricture and broken constitutions, subjected to the operation. Neither hæmorrhage, nor urinary infiltration, rank as causes of death from perineal section. But the stricture almost always returns, unless catheterism or the passage of bougies be practised, occasionally, for some time after recovery from operation.

The *pathological conditions* of stricture submitted to operation, will of course materially affect the proportionate result of apparently successful cases. Perineal section is appropriate for the condition—originally proposed—an almost impermeable stricture, and which is otherwise incurable by dilatation,—and this is always implied, when *properly* speaking of the operation and its results ; but I have seen perineal section performed when, at the time of operation, a full-sized catheter had just before been passed, easily, into the bladder,—and the operation having been performed simply for extravasation of urine.

SPASMODIC STRICTURE.—This kind of stricture is due to the spasmodic action of the muscles surrounding the urethra, and is of a temporary character. It rarely occurs alone, but usually as a supervention on organic stricture, or in connection with an inflamed state of the urethral canal. Spasmodic stricture may occur at any portion of the urethra, by contraction of the layer of involuntary muscular fibres which encircle it throughout its course ; or the membranous portion of the urethra may be constricted by spasm of the compressor urethræ muscle, acting as a sphincter on this portion of the passage, and this is the usual seat of a spasmodic stricture of the urethra.

The symptoms are those of obstruction to the passage of the stream of urine, but of temporary duration although perhaps oft-recurring. They thus differ from the same symptoms in organic or permanent stricture.

Local and urethral conditions, or remote and constitutional conditions, may severally give rise to spasmodic

stricture. The first class comprises, principally ;—the presence of organic stricture ; of inflammation from suppressed gonorrhœal discharge ; irritation of the urethral mucous membrane from various states of the urine, especially a highly acid state,—in various constitutional conditions, as gout ; foreign matters ingested, and expelled by the urine, as cantharides, turpentine, condiments, alcoholic drinks ; and the voluntary retention of urine for too long a time. The second class of causes, comprises, chiefly ;—rectal irritation ; as from hæmorrhoids, fissure, prolapsus, fistulæ, operations on the rectum, ascariides, and anal prurigo ; derangements of the digestive organs, and of the cerebro-spinal system. The *social* circumstances under which the practitioner will commonly meet with spasmodic stricture are characteristic. As affecting the more affluent classes of society ; the indulgence over-night of acid wines, punch, or stimulating food and condiments, at supper-parties or convivial meetings, may be followed next morning by an attack of spasmodic stricture, especially in persons of a gouty diathesis. The restraints of society with regard to the retention of urine, the outdoor amusements of hunting, steeple-chasing, or other rough riding across country, are also circumstances under which spasmodic stricture is liable to occur. Or the picture may be reversed ; the combined effects of cold and exhaustion drives many a homeless wanderer to seek relief at any Hospital during the early hours of our winter mornings. The anxiety and harass of business, the pressure of over study, or of writing against time in newspaper offices, &c., not unfrequently subject the

commercial and the literary classes of society to the penalty of an attack of urethral spasm.

Treatment.—The cause of spasm must be sought, and if possible removed. In an attack of spasmodic stricture, remedial measures must be directed to the relaxation of the muscular contraction. The most effectual antispasmodics are a warm bath, and a full dose of opium,—the tincture or Battley's sedative. I have used a drachm or more of the compound tincture of camphor with advantage. Chloroform inhaled, has sometimes afforded instant relief. Suppositories have not had much effect. This antispasmodic treatment is most successful when the stricture arises from exposure to cold. But, if the gouty diathesis prevails, or the circumstances of origin point to acidity of urine; then, alkalies and other appropriate remedies must be combined. Catheterism should be avoided as long as possible, the introduction of an instrument tending to provoke spasm; and when resorted to, the catheter used should be full-sized or at least one of the higher numbers.

INFLAMMATORY STRICTURE.—An inflamed or congested state of the urethral mucous membrane may occasion a species of temporary stricture. It is less an independent condition, than engrafted on a pre-existing organic stricture, or coincident with spasm.

The symptoms are somewhat peculiar. In addition to obstructed micturition, the penis is turgid and erectile, and the urethra bleeds freely on the introduction of even a moderate-sized catheter; there is intense scalding in passing urine, and the stream

narrows rapidly during the act, ceasing abruptly before the bladder is emptied. The urine is, as it were, shot out at short intervals from the bladder, itself in an irritable state. Perineal heat, fulness, and tenderness, are complained of, when the inflammation extends far back. In all these respects, inflammatory stricture contrasts with that produced by spasm.

As causes of this kind of stricture, may be mentioned, retrocedent gonorrhœa, or suppression of the discharge by exposure to cold or wet, or by an inconsiderate recourse to injections during the inflammatory stage. Indulgence in alcoholic liquors or a stimulating diet, will also contribute to the inflammatory or congested state of the urethra.

Treatment must be conducted on ordinary principles. This urethral condition resulting usually from suppressed gonorrhœa, it will subside on the reappearance of the discharge. Wrapping the penis in a poultice is a simple remedy which I have often found successful.

TUMOURS IN THE URETHRA.—Growths within the urethra, formerly known as “caruncles” or “carnosities” and supposed to be common, are extremely rare. Their nature, according to Sir H. Thompson’s careful examination of recorded cases, seems to be of three kinds :—vascular granulations, situated generally near the external meatus, or projecting; polypoid formations, peculiar to the prostatic part of the urethra; masses of tubercular and cancerous origin. Both the latter kinds of deposit are rarely primary in the urethra, but secondary to disease of the kidney, bladder, or prostate ;

and they seldom appear until the primary disease is far advanced. Either sex is liable to these tumours.

The *endoscope*, an instrument for inspecting the urethral canal, and the interior of the bladder, may afford some aid in detecting and diagnosing urethral formations. Originally suggested by the late Mr Avery, the instruments devised by Desormeaux, Cruise of Dublin, and Wales of Philadelphia, are more or less useful; Wales' endoscope having the advantages of simplicity and cheapness.

The local importance of any such urethral tumour is the degree of obstruction thus offered to the free passage of urine, as a cause of retention.

Treatment.—Urethral growths may be removed on the same principles as similar tumours in other parts;—by Excision, Ligature, Caustics, or the Actual Caustery. Excision can generally be accomplished by means of the scissors, aided by dilatation of the urethra. In this way I have succeeded, especially as regards the female urethra, in removing vascular and erectile growths, which although not of large size were very troublesome. Ligature is difficult, painful, and tedious; unless the growth be polypoid, when it may be looped with silver wire. Caustic applications, as nitric acid or potash, can scarcely be restricted in their action to the growth alone; and the actual caustery by means of the galvanic wire will be preferable.

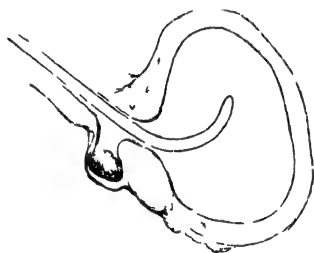
CALCULUS IN THE URETHRA.—Urethral calculus is generally derived from the kidney and bladder, or from a fragment of stone becoming arrested in some part of the canal; but rarely, the calculus forms within the

urethra, by deposit in the sacculus or dilatation behind a stricture. Here urine constantly collecting may give rise to concretion, or it forms around a particle of calculous matter as a nucleus.

The calculus is usually of the lithic acid variety; it more than occupies the calibre of the canal transversely, and assumes an elongated form; it may attain to a very large size. Several calculi are sometimes present; small, smooth, and faceted.

The symptoms are obvious; frequent and difficult micturition, bordering on retention; and the stone may be felt externally in the perineum or detected by introducing a sound, which at once strikes against the calculus, or grates roughly over it when embedded in a dilated portion of the urethra (Fig. 31)*. Rectal

FIG. 31.*



(Liston.)

exploration with the finger is often serviceable. Care must be taken, in either case, to guard the canal on the vesical side, with the finger, lest the stone be pushed back or might slip back into the bladder. Pain in the situation of the calculus is sometimes

experienced, and especially if the stone be rough, and movable in the act of micturition ; but not unfrequently there is no such symptom, and the calculus lies singularly quiescent and unsuspected.

Ulceration and abscess are liable to ensue, resulting in extravasation of urine, and urinary fistula.

Treatment.—The calculus may perchance be expelled in the passage of a full stream of urine. Hence, the Surgeon sometimes avails himself of this natural mode of cure, by directing the patient to retain his water as long as possible, and then to compress the urethra with his fingers in front of the calculus when he endeavours to micturate ; the stream of urine coming out suddenly with a forcible gush, carries before it the stone. The removal of an urethral calculus must, however, generally be effected either by extraction or by incision. When situated in *front* of the scrotum, the calculus can often be extracted ; by passing down the urethra a long, slender, urethral forceps, aided by moderate dilatation ; or failing thus to remove the stone, it should be pushed back into the perineum, and then removed by incision, any incision of the urethra in front of the scrotum generally resulting in a fistulous opening. A stone lodged in the navicular fossa near the meatus, may be eased out by dilatation ; or by a slight incision of the orifice with a probe-pointed bistoury, which I disapprove of, as liable to induce stricture. When the calculus is situated in the *perineal* portion of the urethra, or has been pushed back to that part ; it should be removed by a clean median incision on a grooved staff,—external urethrotomy, at the same time

compressing the urethra firmly with the finger behind the stone, lest it accidentally recede into the bladder. If this happens, a long pair of slender forceps can perhaps be introduced and the stone extracted. After the perineal section, there is little risk of urinary extravasation, and less of fistula or of stricture resulting.

In the *membranous* or *prostatic* portions of the urethra, an impacted calculus may admit of extraction by the median operation of lithotomy. Or, the stone can be pushed back into the bladder, either by means of a large-sized catheter, or by urethral injection. It may then be removed by lithotrity or lateral lithotomy.

Foreign bodies of various kinds have been introduced into the urethra by persons, to gratify some morbid curiosity or prurient feeling ; and any such body having slipped out of reach, surgical assistance becomes necessary. Thus, a *hair-pin* has been passed into the urethra, and the ends expanding, and sticking in the mucous membrane, they cannot be secured with forceps. But, if the pin be compressed through the urethra, with the thumb and finger, a small thin tube may be slid over the ends of the pin, which can then be extracted through the tube.

RETENTION OF URINE.—This term is understood to signify an inability, arising from various causes, to pass any urine, or only a very small quantity. It thus differs from the partial retention of urine in engorgement of the bladder with occasional overflow, and which is dependent on enlargement of the prostate. Moreover, the one is a recent or acute condition, the other an habitual or chronic condition.

The symptoms are not only an absence of micturition,

or the escape of urine by drops after much straining and painful effort; but also, as the bladder becomes distended and rises above the pubes, there is dulness on percussion over that region, extending upwards at length perhaps to the umbilicus. This is accompanied with much distress and constitutional disturbance.

Various causes may give rise to retention of urine, but they are all reducible to two classes:—that of *defective expulsive power*, in *paralysis* involving the abdominal muscles and bladder; and that of *obstruction* to the passage of urine; as dependent on *prostatic enlargement* from any cause,—inflammation, chronic hypertrophy, or tumour, of a sufficient size to block up the internal meatus of the urethra; *perineal abscess*, occasionally; *stricture of the urethra*, organic, spasmodic or inflammatory; *urethral tumours*, *calculi*, or other foreign bodies in the urethra, occasionally.

Unrelieved retention of urine leads generally to *rupture of the urethra*, and especially when the source of obstruction is in the urethra, the canal yielding behind that point, and this event being followed by extravasation of urine; rarely, *rupture of the bladder* occurs in consequence of retention.

Treatment—Retention of urine must of course be regarded with reference to the removal of its cause; but the bladder admits of being entered, and the accumulated urine drawn off, in five different ways:—(1) by catheterism; (2) incision of the urethra through, or behind, the obstruction, usually in the perineum; (3) puncture of the bladder,—through the rectum, (4) above the pubes, or (5) through the symphysis pubis.

Catheterism.—This mode of gaining admission to the bladder will usually succeed; in conjunction with the appropriate treatment for any temporary spasmodic or inflammatory obstruction, which may have become engrafted on an *organic* stricture, from some excess or from exposure to wet or cold,—the circumstances under which retention generally arises. Accordingly, a small-sized catheter is selected, about number 4 or smaller, silver or gum-elastic; and the instrument introduced with due attention to gentleness, caution and patience. The stricture may often yield more readily than might have been anticipated when retention is present, owing to the dilatation effected by the pressure of urine above; or on withdrawing the instrument from just the entrance of the stricture, the urine will often follow in a full stream. If the Surgeon fails in thus affording relief by catheterism; he should have recourse to relaxatives or local bloodletting, as the case may be. With *spasmodic* stricture; the patient should be placed in a warm hip bath, and opium given by the mouth, or in the form of enema or suppository, or chloroform administered; the latter agent being of great value in overcoming both voluntary and involuntary muscular resistance. With an *inflammatory* or congestive state of the urethral passage, as evinced by a turgid penis and tender perineum; local bloodletting from the latter region by cupping, or a dozen leeches, will often effectually subdue this occasion of resistance. After either kind of auxiliary treatment, the introduction of a catheter can generally be accomplished. Recourse to auxiliary measures may be deemed advisable *before*

attempting to pass an instrument, and certainly this would be better than any risk of injuring the urethra by rough manipulation.

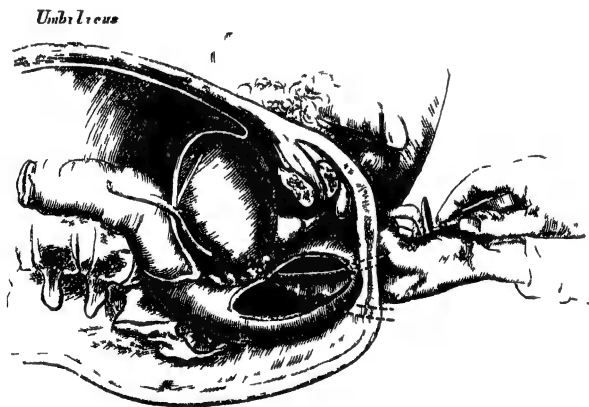
Forcible catheterism, or forcing the stricture as it is termed, will rarely be justifiable; and never in the sense of thrusting a catheter anyhow into the bladder. The forcible dilatation or rupture of an old indurated stricture, as by Holt's operation, offers an occasional resource for the relief of retention.

Incision of the Urethra through, or behind, the stricture.—The first-named point of incision,—through the stricture, is in fact perineal section; and the second—behind, may be performed in a precisely similar manner. The one has the advantage of relieving the stricture as well as the retention; the other leaves the stricture untouched, and it is performed without a guide in the urethra, by carefully deepened incisions so as to hit the passage; the finger having been introduced into the rectum to indicate the point in front of the prostate—the membranous urethra. This procedure was recommended by Guthrie and Liston, and is preferred by Mr Spence, though it has now generally given place to puncture of the bladder per rectum. Both these urethral modes of entering the bladder have the advantage of not directly opening the bladder; and, in relieving retention, they also release any extravasated urine, or matter which may have formed in the perineum.

Puncture of the Bladder through the Rectum.—Having emptied the bowel by an enema, the patient is brought to the edge of the bed and his legs held apart as for

lithotomy. The Surgeon then introduces the left forefinger, oiled, into the rectum, and feels for the posterior margin of the prostate; just beyond which point, bulging fluctuation should be perceptible, especially on tapping the hypogastric region with the other hand. The long curved trocar and canula is then passed along the concavity of the finger, as a guide, to the same point, in the middle line and pushed upwards into the bladder; transfixing the rectum and base of the bladder, in the *trigone* of the latter organ where it is uncovered by peritoneum (Fig. 32). This space is free

FIG 32.



(Bryant)

from adjoining parts; the prostate in front, the reflexion of the peritoneum behind, and the vesiculæ seminales on either side. The trocar is now withdrawn, the bladder emptied, and the canula retained by means

of a waist-bandage and tapes. In performing this simple operation, two additional practical points are worthy of notice; in passing the instrument along the finger, let the point of the trocar be withdrawn into the canula, to avoid wounding the bowel; and leave the canula in, but only just within the bladder, to prevent any irritation of the mucous membrane by the edged-end of this tube. It is allowed to remain for a few days, until urine flows by the natural channel, or until stricture of the urethra or other obstruction has been overcome.

The value of puncture by the rectum has been variously estimated. Mr Cock, who has performed this operation in a large number of cases, is led to very favorable conclusions respecting it; that it is more easy of performance, and less dangerous in its results, than any mode of entering the bladder for the relief of retention. The objections to the operation are—not so much the liability of perforating the peritoneum or seminal vesicles, both of which parts may with care in performing the operation be avoided—but the liability to urinary infiltration, pelvic inflammation and abscess between the rectum and bladder, and a persistent fistulous opening. In one singular case that Mr Erichsen relates, rectal flatus became diffused through the cellular tissue of the°pelvis and down the thighs and nates; an emphysematous condition from which the patient died.

Puncture through the rectum seems to be appropriate only when,—with retention from stricture, there is no sign of abscess or extravasation in the perineum,

the urethra is apparently not dilated behind the stricture, nor the prostate much enlarged; and a catheter cannot be passed under chloroform, with care and patience. These circumstances will considerably restrict the cases for having recourse to this operation.

Puncture of the Bladder above the Pubes is easily performed. A vertical incision in the middle line and just above the symphysis pubis, is made to the extent of about two inches, and carried down through the linea alba, so as just to admit the tip of the finger to reach the distended bladder—below the peritoneal fold, which will have receded owing to the state of distension. An assistant steadies this organ by even pressure with his hands against the abdominal wall, on either side; and a slightly curved trocar is entered downwards into the bladder, the urine drawn off, and the canula allowed to remain for a few days as may be necessary. It is secured by tapes and a waist-bandage.

This operation has been sometimes practised, and is strongly advocated by Mr Paget, of Leicester, and by some other Surgeons of experience. It is not, however, generally resorted to. The objections are, some risk of urinary infiltration, or of a fistulous opening remaining. But there may be no alternative between suprapubic puncture, and rectal puncture; or the perineal section,—when, with impassable stricture, the prostate is considerably enlarged. Rectal-puncture may then be absolutely impracticable, from the impossibility of reaching with the finger behind the enlarged prostate.

Puncture of the Bladder through the Symphysis Pubis.—An ordinary hydrocele trocar of medium size

is introduced, with or without a small preliminary incision, about the centre of the symphysis from above downwards, and in a direction at about right angles to the vertical axis of the body. It is thrust onwards, somewhat obliquely downwards and backwards towards the sacrum, this direction being varied according to circumstances; a flexible catheter is then passed through the canula and retained by a tape. Dr J. M. Brander of Jersey, in 1825, first proposed this operation; and several successful cases have since occurred in his practice, and in the hands of other Surgeons.

In the *Female*, retention of urine may arise from certain *special* causes of mechanical obstruction:—as from the accumulation of menstrual fluid owing to imperforate hymen; during pregnancy, or parturition, from compression of the gravid uterus or the head of the child upon the urethral canal; and uterine tumours, or displacements of the uterus may act in like manner. Hysterical retention, of functional and paroxysmal character, is perhaps peculiar to the female sex.

Treatment consists in the removal of any cause of retention. Thus, in hysteria, remedial measures must be directed to the constitutional condition; and when retention results from some obstruction to the passage of urine, the particular cause must be discovered, and overcome if possible. The introduction of a catheter may be necessary to afford relief, a procedure with which, in regard to the retention of urine in a female patient, the young Surgeon should be familiar, that he may perform it expertly, and with delicacy.

EXTRAVASATION OF URINE.—This may result from

unrelieved retention of urine, in stricture; and generally, the urethra is ruptured behind the seat of obstruction, the bladder very rarely. But, the urethra is also liable to be ruptured by the obstruction arising from an impacted calculus; or by a false passage, from unskilful catheterism; by a fall across a beam, or kick on the perineum; or by fracture of the pelvis, implicating the urethra. In either way, extravasation of urine takes place.

Rupture of the Urethra occurring behind the seat of stricture, the point of rupture is almost invariably the membranous portion of the urethra and just in front of the triangular ligament. Here, the urethra is naturally weak, and has become dilated in the form of a sacculus or pouch, by the constant distending pressure of the urine, resisted by the strictured passage in front. Under this pressure, the weak and dilated urethra tends to yield; but the immediate cause of extravasation seems to be ulceration of the mucous membrane, either from urinary irritation, or as the result of an abscess forming close to this part of the urethra, externally, and which induces ulceration into the canal. The urine escaping from the urethra, or becoming extravasated, into the adjoining cellular tissue, gradually infiltrates this texture beneath the deep layer of the superficial fascia in the perineum; and the fluid following the boundaries of this fascia, it forms a bag, limited by the base of the triangular ligament below, and the rami of the pubes laterally; thence continuing upwards, the scrotum and penis become infiltrated, then the lower part of the abdomen and

outwards to the line of Poupart's ligament on either side ; but there is no extension downwards on the thighs.

The *symptoms* of extravasation are remarkable :— the characteristically bounded swelling, and its increasing size, and extent ; the scrotum and penis especially becoming enormously distended, the one perhaps to the size of a large cocoa-nut, the other to that of a Bologna sausage ; a sensation of sudden relief of the distended bladder is immediately followed by an acute burning sensation in the perineum ; gangrenous inflammation of the cellular texture soon supervenes, the skin assumes a dusky red hue, purplish or black gangrenous spots appear, and frequently one such patch is seen on the dorsum of the penis. Ultimately sloughing of the skin and cellular texture of the scrotum, exposes the testicles bare and pendulous. Sometimes, the urethra bursts just in front of the bulb ; when, in addition to the swelling of ordinary extravasation, the urine infiltrates also the corpus spongiosum of the penis, which is soon followed by gangrene of the glans, in the form of black spots or having a generally black appearance ; thus indicating this further urinary extravasation. The constitutional disturbance is that of low typhoidal depression ; a rapid feeble pulse, dry brown or black tongue, and muttering delirium as death approaches.

The *diagnosis* might be misled by the general resemblance of the swelling to that of phlegmonous erysipelas ; but the above characters, taken in connection with the retention of urine, will indicate the nature of the attack.

Treatment.—The primary indication of treatment is to give an immediate, free and dependent outlet to the extravasated urine, with the fetid purulent fluid and sloughs of cellular texture which soon form. This indication is, therefore, both preventive and remedial. Hence an incision or two should be made in the scrotum on either side of the middle line; exposing the cellular texture, and extending from the front to the back of the bag. Another incision may be made on the dorsum of the penis, and perhaps another over the pubes. A quantity of strong-smelling or ammoniacal urine trickles out, and continues to ooze for hours or days; at the same time, the peculiar appearance of the cellular texture,—its pearly-white colour and tension, or its opaque, sodden, and matted appearance, indicates the urinary infiltration, or the super-vention of sloughing. Tension having been thus relieved, a catheter can often be passed through the stricture into the bladder. This should be done at once, and the instrument retained in the usual manner by means of a waist-band and tapes. The catheter is left *unplugged*, that the urine may drain away from the bladder, and as the instrument occupies the *calibre* of the urethral canal, both these provisions will prevent any further extravasation. By this arrangement also, the ruptured urethra heals over the instrument. A large poultice or warm fomentation, or an antiseptic application, is placed around the scrotum and over the whole extent of the extravasation. The relief afforded by the incisions is almost instantaneous, the patient often soon rallying from the previous state of nervous pros-

tration and low fever. Stimulants, in the form of wine or brandy, with supporting nutriment, may now be given advantageously; and bark with chlorate of potash, or ammonia, will prove very beneficial. Opium also is a most valuable agent; in the early period to counteract the nervous excitement which not unfrequently accompanies prostration, and afterwards when excitement sometimes prevails, to subdue it.

The subsequent treatment of sloughing and granulation,—after a long and trying process of exhaustion and repair, must be conducted on ordinary principles.

Rupture of the Bladder—a very rare consequence of retention—is attended with extravasation of urine into the peritoneal cavity; or more commonly, below the line of the peritoneal reflexion, into the pelvic cellular texture, whence it may secondarily get into the peritoneum by ulceration.

The symptoms are sudden and acute abdominal pain, the patient usually feeling that something has given way; and there is overwhelming collapse. Dulness on percussion over the region of the bladder is now substituted by general abdominal fluctuation and distension, with total incapability to strain out a drop of urine. The most acute peritonitis sets in. Maniacal delirium sometimes appears to supersede the collapse, but death ensues in a period varying from thirty-six hours to four or five days.

The indication of *treatment* would seem to be that an outlet should be given to the urine by puncture of the abdomen. But no such cases are recorded; and

any treatment has hitherto had no effect in averting the inevitably fatal issue.

Suppression of Urine differs entirely from retention, there being no urine secreted.

The symptoms are those of uræmic blood-poisoning, owing to the retention of urea, and the other urinary constituents, in the blood. Commencing sometimes with a rigor, an aching pain in the lumbar region is accompanied with a sense of exhaustion, succeeded by vomiting and feverishness of a typhoidal character, with urinous-smelling perspiration; delirium, convulsions, and coma supervene, and the patient dies in the course of three or four days, or perhaps a week. The suppression is sometimes transient; urine is re-secreted, and the perilous symptoms pass off. No difficulty can be experienced in distinguishing any such attack from that of retention of urine. With suppression, in addition to the other symptoms, no urine is passed, or only a few drops, and the introduction of a catheter fails to obtain any; nor is there supra-pubic dulness on percussion, the bladder being empty.

This arrest of the urinary secretion may be referable to various causes,—a symptom of many diseases. Commonly arising from disease of the kidneys, as congestion; or of a structural character, as in Bright's disease; suppression of urine not unfrequently proceeds from some powerful impression on the nervous system, as the shock of injury or surgical operation. But it may also occur in the course of fevers, or other blood-poisoning. According to this diversity of causation—by renal or systemic disease—the suppres-

sion of urine may be gradual and incomplete, yet fatal ; or an attack, sudden and complete, but perhaps of temporary duration.

Treatment can do very little to restore the secretion of urine. But the effort should be promptly made, by cupping the loins, or dry-cupping ; with sudorific medicines, the warm-bath or hot-air bath, in order to promote sweating, and purgative enemata, thus also to aid the elimination of excrementitious matters. Whether stimulant diuretics should be administered to force the kidneys to renew their function, is a very questionable practice, both in regard to its efficacy and safety. For this purpose, however, cantharides has been given in grain doses, coupled with the application of a large blister to the loins ; and this method of treatment is said to have proved successful in some instances.

URINARY ABSCESS.—Suppuration circumscribed by plastic matter, forming an abscess, is liable to occur close to the urethra in some part of its extent. It may arise from any source of urethral irritation ; usually the collection of urine in the dilatation behind a stricture, or from urethritis, or simply from irritation after the passing of instruments. The suppuration is apparently induced either by ulceration of the mucous membrane, allowing of slight urinary extravasation into the sub-urethral cellular texture, and which thus becomes a direct source of irritation ; or, abscess may perhaps result from the influence merely of the irritation in the adjoining portion of the urethral canal. In the one condition, abscess, proceeding from the canal, may

open externally ; in the other condition, abscess forming outside the canal, may open into it, and externally. Urinary abscess is liable to form in various situations, in relation to the urethral tract ; and it is thence designated, *perineal*, *scrotal*, *intra-pelvic*, and *ante-scrotal* or *penile*. This also represents the order of frequency in the situations of such abscess.

A small, circumscribed, hard, and painful tumour is felt, in the neighbourhood of the urethra ; which scarcely attains any considerable size, unless in the perineum. It is not attended by much constitutional disturbance.

Treatment.—Early incision is absolutely necessary, to prevent further extravasation of urine, or the establishment of urinary fistula. A free, and often deep incision, in the middle line, will give instant relief to tension or afford exit to matter. The part should then be well poulticed.

URINARY FISTULÆ commonly result from urinary abscess, communicating with the urethra, and externally. The internal opening is generally in the membranous urethra,—just behind the usual seat of stricture ; the external opening is most frequently perineal or scrotal ; and the intervening parts are traversed by the fistulous passage, or passages in various and often devious routes. Sometimes,*the fistula is ante-scrotal or penile ; and here the communication with the internal or urethral opening is almost direct. Less frequently, the openings of urinary fistulæ are found in the groins, the upper part of the thighs, the adjacent part of the nates, or even above the pubic symphysis. In size, the

fistulous passages differ considerably; some admitting only the finest probe, others readily the finger. In point of number also, they vary remarkably; penile fistulæ being usually single, whereas, scrotal and especially perineal fistulæ are often numerous. Fifty-two openings, Civiale found in one such case. The surrounding structures differ so much in their condition as almost to warrant the distinction of urinary fistulæ into two classes; the *simple* or healthy fistula, and the *indurated* fistula. In the latter condition, the fistulæ are sometimes connected with cavities secreting pus, and detaining in their interior some quantity of the urinary secretion. The surrounding parts share the induration; the scrotum and penis becoming enormously enlarged and brawny or almost cartilaginous. Another and more important distinction, which characterises a class of urinary fistulæ, is that wherein the urethral opening results from actual *destruction* and *loss of substance*, by sloughing; in consequence of urinary extravasation, phagedænic ulceration, or mechanical injury. A portion of the floor of the urethra having been destroyed, and the tissues intervening between it and the external surface; the urethral mucous membrane of the upper aspect or roof of the canal, becomes visible from the outer orifice of the fistula. Such apertures may be found in similar situations to those of abscess-fistulæ; as perineal, scrotal, and ante-scrotal or penile fistulæ.

The symptoms of urinary fistula, having reference to the act of micturition, are characteristic of the existence of such fistula; and are tolerably distinctive as to its situation, size, and mode of origin.

In all urinary fistulæ, the urine escapes partly, at least, by the fistulous opening, or openings; in the latter condition, the urine spurting out perhaps as if it were issuing from the rose of a water-pot. This may be often seen in perineal and scrotal fistulæ, where numerous openings frequently co-exist. The situation of the internal opening is less correctly indicated, owing to the devious routes of the fistulous passages. But the seat of stricture will supply this information. According to the size of the fistulous communication, more or less urine will escape through the unnatural passages; and proportionately, less or more by the urethra. And the mode of micturition in this respect is tolerably diagnostic of fistula which results from destruction of a portion of the urethral canal; the whole or nearly the whole of the urine then passing by the artificial channel in a full stream.

Treatment.—When a stricture, followed by abscess, is the cause of the fistula, the primary indication of treatment will be the removal of that condition. This may be done in the usual manner; by dilatation, internal urethrotomy occasionally, external urethrotomy more commonly,—and usually the perineal section, owing to the situation of the stricture. Having thus succeeded in enabling the urine to flow by the natural channel; the fistulous passages are set at rest, and they not unfrequently contract and close. Thus, both *simple*, and even indurated, urinary fistulæ, may be cured.

But *old*, *indurated* fistulæ, are indisposed to heal,

although the original cause has been thus removed. Recourse must be had to additional treatment for this purpose. The measures remedial in chronic fistulæ generally, are here also appropriate, and may have to be tried in succession. They are chiefly ; stimulating applications to the fistulous tract ; compression ; and incision along the course of the fistula to induce healing from the bottom. Of *stimulating applications*, various agents have been employed ; in the form of injection by means of a fine syringe, as tincture of cantharides, solutions of nitrate of silver, sulphate of copper or of zinc. A probe coated with fused nitrate of silver, may be passed along the tract occasionally, and this will often succeed in causing contraction. The actual cautery is sometimes curative, applied in the form of a red-hot wire, or the galvanic-wire cautery, which can be conveniently introduced along the tract before being heated by the current. *Compression*, by means of an india-rubber air-pad, applied to the perineum, has proved successful in some cases of perineal fistulæ. *Division* of the fistulæ along their course nearly to their origin in the urethra, can be accomplished as usual, with a grooved director and narrow blunt-pointed bistoury. Several passages may be thus thrown into one, and strips of lint should then be inserted to provoke granulation from the bottom of the tract.

During recourse to these measures for the cure of urinary fistulæ, any passage of urine along their course, must be prevented, by regularly using the catheter three or four times a day. The patient may be

instructed how to do this for himself, at every call of nature.

Respecting the eligibility of these modes of treatment; in long, narrow, and tortuous fistulæ,—stimulation and compression seem to be the most appropriate; when the fistulæ are large and numerous,—incision is more suitable, the perineum and scrotum being sometimes quite riddled in all directions.

Larger-sized urethral openings, in consequence of actual *destruction* of some portion of the wall of the canal, require operative interference of a plastic character, to repair the loss of substance.

Urethro-plastic operations are designed to effect reparation in one of two ways; either by simple closure of the fistulous aperture, or by borrowing the surrounding integument to accomplish this object. These procedures are severally applicable according to the part of the canal where the opening exists.

Perineal fistula may admit of closure by simply paring the edges down to the urethra, and uniting them with quilled sutures, or by Bozeman's buttons.

Ante-scrotal or penile fistula is much more difficult to close, owing to the want of substance in the coverings of the urethra at this part of its extent, and the liability of the part to disturbance by erection of the organ or other motion. When the opening is *small*, Dieffenbach's mode of closing it may be applicable. It consists in first stimulating the edges, by frequently touching the surrounding skin with the strong tincture of cantharides, the day before the operation; and then using the "lace suture." A sound is introduced into

the urethra beyond the opening; the operator takes a small curved needle, sharp at the point but not at its sides, armed with a stout silk waxed thread, and by means of a needle-holder introduces it beneath the skin at about three lines from the border of the fistula. The needle is carried deeply, but not into the urethra, and made to emerge at another point; then dipped again, and so on by three or four stitches, carried round the opening, until it emerges at the point of entrance. The thread, thus embedded in the cellular texture around the fistula, is drawn by its two ends together, so as to close the opening; and then fastened by a knot. In three or four days, the ligature may be divided and drawn away. A *larger-sized* aperture will probably require some substitution of the surrounding skin; and this may be accomplished by Nélaton's operation, as follows:—The edges of the fistula having been pared, the skin around to the extent of about one inch must be dissected by passing a small narrow-bladed knife subcutaneously around the aperture; thus forming a detached area of integument, which is brought together over the opening and the edges united by a few points of fine suture. This procedure may sometimes be advantageously modified by making lateral incisions, and then passing across underneath the flap a slip of india-rubber, to prevent contact of the urine which would disturb the process of adhesion in the line of closure over the urethral opening.

During the course of reparation by any of these urethro-plastic operations, the urine must always be

drawn off gently by a catheter, three or four times daily.

URINARY-VAGINAL, AND UTERINE FISTULÆ.—Fistulous openings may be established ; (1) between the urethra and vagina ; (2) between the bladder and vagina ; or (3) between the bladder and uterus. These communications result ; from contusions or laceration in parturition, the introduction of foreign bodies, the effects of calculous concretions in the bladder, or operations for their removal. Openings caused by the extension of cancerous ulceration are here omitted, as such fistulæ are quite incurable.

Much, and persevering attention has been given of late years to the Surgical treatment of the various forms of simple fistulæ ; and results have been obtained in a large number of cases, sufficient to establish the operative cure of these distressing conditions as a finished achievement. We are chiefly indebted for this addition to Surgery, to the labours of Dieffenbach, Bozeman, Mr Baker Brown, Dr Marion Sims, Professor Simpson, Mr Bryant, and Mr Spencer Wells.

The principal features connected with the operations as more recently practised, and which have led to their increasing success, are thus enumerated by Mr Jonathan Hutchinson. Speaking chiefly of vesical fistulæ ; 1st the use of chloroform, which facilitates the difficult step of the dissection ; 2nd the use of metal sutures instead of silk ; 3rd the avoidance of the vesical mucous membrane, both in the dissection, and in the application of the sutures ; and 4th increased attention to keeping the bladder empty afterwards. It may be

added, that metallic or wire shields, adjusted over the line of union, were much relied on a few years since; but they are now generally discarded in favour of sutures alone.

Vesico-vaginal fistula, may be taken as the type of the three urinary fistulæ, relating to the vagina and uterus. The requisite operation consists in completely paring the edges of the vaginal aspect of the fistula, and then uniting them by suture. But many particulars should be observed, as tending materially to the success of this procedure; and they are tersely stated in the following summary by Hutchinson, which I can endorse by my own experience:—The instruments used are small tenotomy-like knives, forceps, needles, and fine silver-wire. Instruments for carrying the wire have also been devised; as Startin's tubular needle. The patient should be in her best state of health, and the bowels have been well cleared out. Chloroform having been given, the woman is placed either on her side with the knees well drawn up, or in the usual lithotomy position. The parts being thoroughly exposed by a duck-bill speculum, and the nates being held widely apart by an assistant; the operator proceeds to drag the opening as low down as possible, with a view to facilitate the paring of the edges. This may be accomplished either by hooks, blunt or sharp; by means of a metal suture; or by the introduction of a flexible sound through the urethra, which is brought out again through the fistula, and then bent backwards. This latter plan furnishes the Surgeon with a most efficient hook, and one which

cannot easily slip. In paring the edges, it is necessary thoroughly to denude every part; for if the smallest portion of mucous membrane be left, it may prevent union. None of the mucous membrane of the bladder must be removed. The wound should present a bevelled oblique line, slanting from a large vaginal opening to a smaller vesical one. The denudation being complete and free, sutures are next to be introduced. These should be passed obliquely from at least a third of an inch outside the edge of the incision. They must not include the mucous membrane of the bladder. The tightening and tying of wire sutures is easily accomplished by the fingers. Care must be taken not to pull them too tight, so as to invert the edge of the vaginal mucous membrane.

After-treatment is simple:—The small double-curved silver catheter, invented by Dr Sims, or an ordinary gum-elastic one, should be passed and retained unplugged; that the urine shall continuously drain out of the bladder. This should be constantly watched; and the instrument cleansed and then re-introduced twice a day. The patient must lie on her side with the knees drawn up; and her general health be well sustained. It is of the utmost consequence to prevent the action of the bowels for at least a week; and this may be accomplished by administering a full dose of opium soon after the operation, and maintaining its influence subsequently by smaller doses. Dr Sims lays much stress on this point, as an element of success. The removal of the sutures prematurely is a greater evil than their unnecessary continuance; they should cer-

tainly not be withdrawn before the ninth or tenth day, and then with great caution.

Urethro-vaginal fistula is more easily closed by a similar procedure; but union takes place less readily, owing to the unavoidable pressure of the catheter on the line of union. This I have experienced in my own operations. It is better therefore to adopt the practice now I believe generally pursued; that of withdrawing the urine occasionally, by gently passing a catheter, or even to allow micturition, from time to time, without interference. Scrupulous cleanliness should of course be observed.

Vesico-Uterine fistula, is that condition wherein the fistulous communication exists between the bladder and cervix uteri. Certain modifications in the plan of operation will be required. It might become desirable to obliterate the upper part of the vagina, in order to connect the uterus with the bladder; thus allowing the menstrual fluid to pass through this organ, but preventing incontinence of urine.

These operative procedures may have to be repeated a second, or third time, and even several times, in the same case; partial closure only being effected in the first instance, and afterwards more and more completely. Such temporary failure, however, will not weary the perseverance of the true Surgeon, nor the endurance of the patient, who is too glad to get rid even by degrees, of a most troublesome, offensive, and socially distressing urinary leakage. But, it not unfrequently happens that a pin-hole opening, only, remains, defying any plastic procedure. In common

with other Surgeons, I have had to contend with this difficult residue of the operation. No means of closing the aperture will, I believe, prove effectual except the introduction of a red-hot wire, or better,—the galvanic-wire cautery.

CHAPTER VI

URINARY DISEASES ; DEPOSITS, AND CALCULI

URINARY DISEASES are best introduced by observing the characters and composition of the urine in health, as the representative and exponent of blood-conditions in health.

HEALTHY URINE

Physical Characters.—A fluid, clear, of a bright amber colour, peculiar aromatic odour, and specific gravity or weight, varying from 1·015 to 1·030, the average being 1·020; the quantity secreted varying from 30 to 80 fluid ounces in twenty-four hours, the average being about 52 ounces. Slightly acid, except after food, when it becomes neutral or alkaline, during digestion in the stomach—chymification.

Chemical Composition or Constituents—qualitative and quantitative—Mean or average in twenty-four hours, for the adult male:—

	Grains.
Urea	512·40
• Uric acid	8·56
Phosphoric acid	48·80
Oxalic acid	1·42

	Grains.
Brought forward	571·18
Sulphuric acid	31·11
Hippuric acid.	34·50
Chlorine	126·76
Extractives*.	154·00
Soda	125·37
Potash	58·21
Ammonia	8·58
Lime	3·55
Magnesia	3·09
Iron	undetermined
Mucus (adventitious)	7·00
Total { Solids	1123·35 Grains, weight.
{ Water	52½ Ounces, measure.

In estimating the quantity of any urinary constituent excreted in twenty-four hours, the weight of the body and activity of the functions must both be compared therewith. Thus, the excretion of only 150 grains of urea, in a person whose weight is 80 lbs., would be a healthy proportion; but if the weight be 170 lbs., that quantity would be very disproportionate, and indicate a diseased condition of serious or fatal consequence.

The physiological origin of the urinary constituents is represented in the following tabular view, taken from Dr Golding Bird's well-known work.†

* *E.g.*, creatine and creatinine, and colouring matters.

† 'Urinary Deposits,' &c. Edited by Dr. Birkett.

1. *Organic Products*

1st. Ingredients characteristic of the secretion produced by the destructive assimilation of tissues, and separated from the blood by the kidneys. } Urea, uric acid, creatine, creatinine, colouring and odorous principles.

2nd. Ingredients developed principally from the food during the process of assimilation. } In addition to the above, hippuric acid, lactic acid; accidental constituents.

2. *Inorganic Products*

3rd. Saline combinations separated from the blood, and derived from the food. } Sulphates, phosphates, chloride of sodium, and all soluble salts taken with the food, and often undergoing decomposition in the system.

4th. Saline combinations chiefly generated during the process of destructive assimilation. } Sulphates.
Phosphates.

3. *Ingredients derived from the Urinary Passages.*

5th. Mucus of the bladder.

6th. *Débris* of epithelium.

7th. Phosphate of lime.

Morbid conditions of the urine are—either increased or diminished proportions of its normal constituents, or new adventitious ingredients, those, perhaps, of most practical importance being sugar, albumen, and bile.

The urinary bladder can well tolerate the normal urinary constituents, *i. e.*, healthy urine, which only sufficiently irritates that organ to suggest, from time to time, the evacuation of its contents, as the temporary receptacle of this excretion. But if either of the many constituents adverted to be secreted in excess, or if some new one be present, the bladder at once rejects the unaccustomed urine, the functional condition of excitement,—irritability of the bladder, with, therefore, too frequent and painfully urgent micturition, is induced.

Morbid conditions of the urine are, in common with its healthy conditions, immediately referable to corresponding causative conditions of the *blood*; but their pathological *origin*—like unto the physiological origin—within the body is remote.

MORBID CONDITIONS OF THE BLOOD.—In *health*, the composition of the blood is ever changing, by the addition of new matter, received through the process of digestion,—the primary assimilation of food, and as effete matter or waste of the textures, through their destruction in the course of nutrition,—secondary assimilation; and, furthermore, ever-changing, by the abstraction of old, effete matter,—or excretion through the kidneys, skin, liver, and other excreting and secreting organs.

So likewise, in various *diseases*, the composition of the blood is ever-changing, by the addition of new morbid matter, through primary *mal-assimilation*, or secondary *mal-assimilation*, or by the co-operation of both these perversions,—the former representing that of digestion, the latter that of nutrition; and, furthermore, ever-changing, by the non-abstraction or retention of morbid matter,—*mal-excretion* through the kidneys, skin, liver, and other excreting and secreting organs.

(1) *Mal-assimilation (a) in Nutrition*.—This source of blood-disease was first investigated by Prout,* and afterwards, physiologically, by Liebig,† who designated the destructive stage of nutrition “destructive metamorphosis” of tissues. Prout was inclined to believe that in all cases of secondary *mal-assimilation*, the *formative* and *destructive* stages of this process are both perverted in a greater or less degree.

The various kinds of textures, as chemically distinguished—the albuminous, the gelatinous, the oleaginous—may severally generate morbid conditions of the blood, by their *destructive* metamorphosis in secondary *mal-assimilation*.

Lithic Acid ($C_{10}H_4N_4O_6$).—Albuminous tissues undergo decomposition into lithic acid, rather than lithate of ammonia; and the blood being thence surcharged with this acid, represents the “gouty diathesis.”

Urea ($C_2H_4N_2O_2$), in like manner, resulting from the normal destructive metamorphosis of highly nitrogen-

* ‘Nature and Treatment of Stomach and Renal Diseases.’

† ‘Animal Chemistry.’ Translated by Gregory.

ous tissue—*e.g.*, muscle—may possibly be produced in excess, by such transformation taking place too rapidly for excretion, by the urine, to eliminate it proportionately; or, again, the excess may possibly arise from uric acid by its oxidation, as urea can be thus formed artificially.

Phosphoric Acid (PO_5).—Textures abounding in phosphoric acid, *i.e.*, the brain and nervous system, by their destructive metamorphosis in an over-active degree, induce the “phosphatic diathesis.” The blood is surcharged with this acid, in combination with alkaline and earthy bases; forming, respectively, phosphates of soda, and those of lime and magnesia. The *deposition* of the *latter* in the urine, the only phosphates ever *deposited*, does not represent their total amount, but only the alkalescence of the urine, as explained under “phosphatic urine.” One general law appears to govern the evolution of phosphoric acid and the formation of phosphates: they always follow nervous exhaustion, particularly that resulting from over brain-work. Of this source, two excellent examples are given by Golding Bird, in the work referred to.

Oxalic Acid ($\text{HO}, \text{C}_2\text{O}_3$).—The gelatinous textures may possibly, according to Prout, by their destructive metamorphosis, be converted into oxalic acid, which, entering the blood, represents the “oxalic acid diathesis.”

Sulphuric acid (HO, SO_3), derived chiefly from the oxidation of the sulphur in the destructive metamorphosis of the albuminous tissues, will, therefore, be

produced in excess by their too rapid and abundant transformation in this stage of secondary assimilation. The oxidation of cystine and taurine is another probable source.

Hippuric acid ($\text{HO}, \text{C}_{18}\text{HNO}_5$), a highly carbonaceous acid, may, perhaps, be produced in excess by the destructive metamorphosis of nitrogenous tissue.

Lactic acid ($\text{HO}, \text{C}_6\text{H}_5\text{O}_5$), in excess, may also have a similar origin; muscular tissue everywhere abounding in lactic acid.

Chloride of sodium (NaCl) and chloride of potassium (KCl), in excess, are, perhaps, produced by the destructive transformation of the tissues in general.

Sugar of the grape—glucose ($\text{C}_{12}\text{H}_{12}\text{O}_{12}$) in the blood—and thence the origin of diabetes mellitus, may possibly proceed from the gelatinous textures (Prout); but the liver-origin of the glucose from glucogen, as shown by Claude Bernard, is now the generally admitted source.

(b.) *In the process of Digestion*, perversions of primary assimilation generate morbid conditions of the blood, similar to those which emanate from perversions in the course of nutrition.

The perversions in question are referred by Prout to the stomach, the duodenum, and the chyloferous system.

Lithic acid may be a product of the imperfect digestion of albuminous food in the stomach. Mal-assimilation in the duodenum generally results from that in the stomach, and that which takes place in the chyli-

ferous system of vessels may form the pseudo-albuminous matter of scrofula.

Urea.—An excess of nitrogenous food will probably produce excess in the blood; a considerable increase taking place in the urine after such food.

From this triple source the blood becomes contaminated, unless the product of mal-assimilation in the stomach and duodenum is evacuated as fæcal, ill-digested food.

Phosphates.—An excess of phosphates in the blood will result from an undue proportion of *food* containing them. A vegetable diet has this effect, of which the experimental observations of Dr Bence Jones* afford ample proof. Alkalies, taken continuously, favour the production of phosphates, by supplying the base with which phosphoric acid may combine.

Oxalic acid is occasionally introduced by particular kinds of food—*e.g.*, common rhubarb, sorrel, &c.; and then, if *hard* water, which contains lime, be drunk, oxalate of lime is formed in the blood. But this acid is more frequently generated by mal-assimilation of saccharine matters during the digestive process, as was first suggested by Prout.

Sulphuric acid, partly derived from the sulphates of the food, whether vegetable or animal, and from the oxidation of sulphur in its course through the body, may introduce or produce an excess, when either mode of food-origin is increased beyond the requirements of the system.

Hippuric acid, in excess, may arise from food itself

* 'Animal Chemistry,' &c.

too rich in carbon, *i.e.*, vegetable, as compared with animal food. Medicines containing benzoic acid have a similar effect, this acid being converted into hippuric acid during its passage through the system.

Lactic acid, in excess, may also have a food-origin; sugar, or amylaceous matters, by their decomposition, producing lactic acid, and certain sour kinds of food, as sour milk, or cabbage, having already undergone such decomposition.

Chlorides of sodium and potassium are introduced in excess, by articles of food abounding in these salts, *e.g.*, salted provisions.

Sugar.—Prout first suggested the possibility of sugar being a product of the primary *mal*-assimilation of farinaceous matters, and thence the origin of diabetes mellitus. It is well known that starch and gum are converted into sugar by the action of acids, and equally indisputable that the stomach is prone to acidity in diabetes—a clinical fact which accords with the view advanced by the authority referred to. But the actual production of sugar during digestion in diabetes was established by M'Gregor.*

Claude Bernard has since apparently demonstrated the constant production of sugar, alike from azotised and unazotised matters, by the liver, in health, and therefore the probability that this organ is at least one source of sugar in diabetes, by over-activity of its function, in respect of sugar-production.

Certain it is that sugar abounds in the blood of

* 'Medical Gazette,' 1837.

diabetic patients, as shown by the analyses of Maitland and Ambrosiani.

Oleaginous matters are probably generated freely by primary mal-assimilation in persons who have a marked tendency to obesity, and thence the blood becomes surcharged with fat. This excess not being relieved by secondary assimilation, it accumulates in the body, encompassing and invading the textures interstitially; and, in the process of nutrition, usurping and occupying the place of their proper structural elements, it becomes apparently one mode of fatty degeneration—by the substitution of fat; yet the blood remains surcharged from its original source of continued production.

All the foregoing conditions of urine have reference to those blood-diseases which result either from perversions of nutrition, or of the functions of the digestive organs, or from both; and which manifest themselves by these morbid states of the urinary excretion, they being in their turn signs of the existing blood-disease. The kidneys are merely the channels through which the noxious matter, whatever it be, is excreted from the blood.

(2.) *Mal-Excretion (a) through Kidneys*.—The kidneys are liable to undergo certain structural changes, whereby some one or more of the urinary constituents ordinarily excreted is retained in the blood, and thus adding a noxious matter thereto, gives rise to its own peculiar blood-disease. In any such case the morbid state of the urinary excretion is the sign of that structural change which the kidneys are undergoing or have

already undergone. These organs, and the blood-disease induced, stand in the relation of cause and effect; while the peculiar state of the urine is the sign of the particular cause in operation. I allude chiefly to congestion of the kidneys causing suppression of urine, and to their fatty or granular degeneration—Bright's disease, as originating a certain blood-disease by the retention of urea and excretion of albumen; the renal disease being manifested by corresponding changes in the urine secreted—viz., the absence or diminished proportion of urea and water, and the presence of albumen in variable quantity.

All these urinary changes are reflected in the blood. Analysis discovers a large accumulation of water—tending to dropsical effusions, the retention of urea, and a diminished proportion of albumen, together with a rapid decrease of the red particles of the blood. "I am acquainted," writes Sir Robert Christison, "with no natural disease, at least of a chronic nature, which so closely approaches hæmorrhage in its power of impoverishing the red particles of the blood."

No other very marked changes occur. Subjoined are the results of Franz Simon's observations as quoted by Dr Owen Rees.*

	Water.	Blood Fibrin.	Corpuscles.	Solids of Serum.
Health . . .	775·7	3·8	137·1	83·4
Albuminuria .	808·3	3·9	133·9	54·8 (1)
	859·2	8·2	75·5	57·2 (2)
	855·5	4·5	42·7	97·3 (3)

(1.) A man aged 55.—First stage of granulation, anasarca: urea in blood.

* 'Nature and Treatment of Diseases of the Kidney, connected with Albuminous Urine, Morbus Brightii.'

(2.) A man aged 44.—First stage, more advanced than (1) *anasarca*, *pneumonia* : *urea* in blood.

(3.) A man aged 23.—Advanced granulation, after *scarlatina*.

(b) *Skin-Excretion*.—Turning from this to other excretions—considered with regard to the etiology of blood-diseases—the *sweat* being complementary to the excretion of urine, comes next in order. While, however, much is known respecting the structure and functions of the sudoriparous glands, chiefly by the researches of Purkinje, Breschet, and Roussel de Vauzeme, little can be said specially respecting this glandular system in its causative relation to morbid conditions of the blood; thus affording another proof, if more be necessary, of the incompetency of Physiology to predetermine anything in Pathology. The latter must be founded on independent observation; and in respect of the sudoriparous glands, their pathology has not yet been separately investigated. Arrest of the function of these glands—checked perspiration—has hitherto been observed only in connection with febrile diseases; “but,” remarks Erasmus Wilson,* “it is probable that the perspiratory secretion, like that of other secreting glands, may be diminished and checked, as a consequence of inflammatory disorder of the sudoriparous glands themselves, independently of the rest of the organism. Dryness of the skin, occasionally met with, is owing to the absence of secretion by the sebiparous or sebaceous glands.” •

Arrest of the perspiratory secretion must obviously

* ‘Diseases of the Skin,’ ed. 4.

induce some morbid condition of the blood, by retention of the *excrementitious* matters which should be eliminated. Rheumatism is usually attributed to this cause, under the influence of exposure to wet and cold.

The perspiratory secretion of certain parts of the body—*e.g.*, the axillæ and feet—is apparently specially *excrementitious*; and the sudden suppression of rank sweat therefrom has been followed by typhoid symptoms of the worst character, obviously due to retention of poisonous matter in the blood.

Certain constituents of the *urine* and *bile*—*e.g.*, lithic acid and bilin respectively—may be detected in the perspiration occasionally, and then the blood is assuredly poisoned. Besides, however, being *complementary* to other excreting organs, it would appear that the skin, in common with all such organs, eliminates *many other* matters, which are either of a poisonous nature, or, if innocent, have accumulated in excess; and which, in either case, had been taken into the circulation. The following substances have been detected in the sweat:—Quinine, sulphur, mercury, iodine, iodide of potassium, assafoetida, garlic, saffron, olive oil, rhubarb, indigo, Prussian blue, and copper.* Suppressed elimination of these matters will cause morbid conditions of the blood, severally varying in importance with the particular matter retained. The perspiration has been known to undergo certain inexplicable alterations of *colour*, becoming blue, green, saffron, yellow, ruby, or black; and unless such changes are due to

* 'General Pathology,' Stark, p. 1127.—'Elements of Physiology and Therapeutics,' Baumgärtner, p. 486.

colouring matters only, they bespeak some more serious perversions of excretion, which, if checked, will inevitably be reflected in the blood.

The sweat sometimes becomes altered in another sense. Instead of being excrementitious, it may carry off some one or more of the *essential* constituents of the blood, which is thus robbed of what should be retained. For example, albumen has been found in the sweat in rheumatic fever, gastric, putrid, and hectic diseases, and on the approach of death.* Or, some essential constituent of the blood, and one that is also a normal constituent of the sweat, may be secreted in *excess*; affecting the blood's healthy composition and properties, by altering the *proportion* of its essential constituents. For example, an undue quantity of sweat is sometimes secreted in very hot weather, thereby draining off from the blood an excessive quantity of *water*. This disorder, known as idrosis, was witnessed by E. Wilson in several instances, during the burning August of 1856; and a similar condition was a prominent feature of the "sweating sickness" that occurred in England in the sixteenth century.

Possibly idrosis should be regarded as an excessive secretion of more than water; that *all* the constituents of sweat—which, *as a whole*, is properly excrementitious—are simultaneously eliminated only in *undue quantity*; nevertheless, the blood's composition becomes altered, relatively to the *proportion* of *other* excrementitious matters passing into the circulation.

* *Op. cit.* Wilson.

The *balance* of *effete* matters of various kinds, ever mingling in the blood, is disturbed; and whatever relatively preponderates will represent a blood-disease, enduring until such balance is readjusted by a compensatory discharge of other excretions of an opposite character. This view of idrosis, and its relation to the constitution of the blood, implies a pathological principle, well illustrated by the consequences of an excessive discharge of *other* excretions. Bilious flux, for example, as compared with a diminished proportion of urine excreted, gives rise to a constitutional disturbance, which, agreeably to the principle alluded to, is thus interpreted by Dr C. J. B. Williams:—Urine contains a large proportion of azote; its excessive separation from the blood, therefore, leaves a comparative predominance of hydrogen and carbon in this fluid. Bile, again, abounds in hydrocarbon, and its copious removal, therefore, leaves a superfluity of azote. Accordingly, a flux of bile is either accompanied by a highly loaded state of the urine, or by fever, not subsiding until the urine becomes very copious, or deposits an abundant sediment. The most probable interpretation of this fact is, that excessive secretion of bile disorders the composition of the blood: so long as the kidneys rectify this disorder, by separating in greater abundance the solid contents of the urine, no fever results; but if the kidneys fail in their task, fever ensues and continues until they resume it; then a free secretion from them, and copious urinary deposit, is symptomatic that the fever is declining.

* 'Principles of Medicine,' 1856, pp. 131, 132.

(c) *Liver Excretion*.—Contrasting with the blood-disease consequent on *bilious flux*, an opposite state of the blood, signified by jaundice, is the offspring of a continued *deficient* elimination of bile from the system. This occurs in either of two ways : by some mechanical impediment to the free escape of bile through the ducts into the duodenum, or by the suppression of bile-secretion. The structural conditions will be hereafter noticed in connection with the Symptoms and Treatment ; but in either case jaundice arises.

MORBID CONDITIONS OF THE URINE.—Having briefly traced the general pathology of the blood, so far as it is a primary part of urinary pathology, we proceed to examine the accompanying morbid conditions of the urine. Their diagnostic interpretation is essential to the removal of those conditions of the blood, of which they are also but the symptomatic manifestations.

Each such (symptomatic) condition of urine will be preceded by a tabulated view of the several diseases with which it will be found, according to our present experience, to be associated. In none of the diseases thus indicated, is the particular state of urine *invariably* present in every case, nor through the whole course of the disease ; nor is the *amount* of increase or diminution expressed. But, allowing for these unavoidable omissions, this arrangement will be convenient for ready reference in connection with the several conditions of urine described.

Urine for Examination.—The diagnostic interpretation of any particular state of urine must obviously

relate to its source or origin in the system. The *products* arising and accruing from mal-assimilation—whether by that of digestion (primarily) or of nutrition (secondarily)—and which appear in the urine, can be selected for examination by observing a very simple precaution with regard to the sample of urine.

Urine secreted at from three to six hours after a meal, represents the products of digestion ; while that secreted several hours subsequently, when the urine from this source has run off, represents the products of nutrition in its destructive metamorphosis, or the *débris* of the textures. The latter may be called *urine of the blood* ; and if examined in the morning before breakfast, after an interval of fasting from over-night, will be found to contain, unlike the *urine of digestion*, the waste of the textures. To make this observation complete, the bladder should be emptied over-night, to preclude any admixture of the urine then in the bladder with that which is secreted during the night. By this precaution, the products from these two sources of urine can be detected and distinguished, in most cases, with approximate certainty.

Changes in Urine from Decomposition, after Emission.
—*Stale Urine.*—The changes which take place in the urine after emission, and as the result of decomposition, must not be mistaken for those which represent morbid conditions.

Healthy urine may thus undergo departures from its ordinary slightly acid reaction, in two opposite directions ; becoming *highly acid*, or turning to an *alkaline* condition.

(a) *Hyper-acidity, or Acid Urinary Fermentation* (Scherer).—This change consists in the generation of lactic acid and acetic acid; the mucus of the bladder acting apparently as a ferment on the urinary pigment. Like other fermentive processes, therefore, this one is prevented or arrested by alcohol or boiling, or by removing the ferment—vesical mucus by filtration. The changes consequent on this production of acidity are, a precipitation of the amorphous urates, then of uric acid, and often of oxalate of lime. Simultaneously, confervoid vegetations—the mould or sugar fungus—are apt to appear. Acidity, increasing for some five or ten days, declines as putrefaction succeeds. An ammoniacal reaction and odour now supervene, with opacity of the urine from the development of myriads of minute linear particles—vibrios. The amorphous urate deposit has become changed into dark round masses of urate of ammonia, uric acid crystals are replaced by bright prisms of triple phosphate, and amorphous phosphate of lime sinks as an abundant sediment. The growth of confervoid vegetations is arrested with the change of reaction, and they perish as putrefaction is established. Exceptions to this order of change occur. Urines of low acidity or of low specific gravity do not undergo any marked increase of acidity; but they become ammoniacal in a day or two, or possibly in a few hours.

(b) *Alkalescence*, in exposed urine, results from the transformation of urea into carbonate of ammonia, and this change may be induced by contact with any decomposing matter, stale urine in particular.

(c) Certain *organic deposits*, as blood corpuscles, renal epithelium, and uriniferous tubule casts, are soon destroyed by an exposure of twelve or twenty-four hours, especially in urine of low specific gravity. But pus corpuscles, scaly epithelium, and spermatozoa, retain their microscopical characters for a much longer period, even to an advanced state of urinary putrefaction.

Bearing in mind all these peculiarities of decomposed urine, the rule should be to examine any specimen of urine within a few hours after its emission.

Clinical Examination of the Urine.—From a practical point of view, an examination of the urine is a much more simple procedure than that whereby original investigations are conducted, as commonly detailed in works on Urinary Pathology, but which necessarily involves a minute knowledge of chemical analysis and of microscopic manipulation beyond the requirements of clinical practice, or the time at command of those who are so engaged.

The following *method of examination* indicates the order of procedure which will commonly be found sufficient; and the essential particulars to be *noted* respecting morbid conditions of the urine.

(1.) *Physical Characters.*—Observe the colour, clearness or turbidity, any deposit or foreign body, odour, and specific gravity, as shown by the urinometer. Reaction—acid, alkaline, or neutral, as tested by a slip of blue litmus paper, or yellow turmeric paper; the one becoming red, when the urine is acid, the other brown, when the urine is alkaline.

A deposit—observe its colour, admixture with, or

separation from, the urine, and wheter floating on the surface as a pellicle, suspended as a cloud, or precipitated as a sediment, apparently amorphous or crystalline.

(2.) *Chemical Tests*—(a) for Deposits. Effect of *heat*.—Pour a sample of the urine, with deposit, if present, into a test-tube, and over the flame of a spirit-lamp heat gradually to ebullition. Observe the disappearance of turbidity, as when a deposit of *lithates*; or the appearance of turbidity, as by a deposition of *phosphates*. Or the latter appearance may be the coagulation of *albumen*. Drop a few drops of *strong nitric acid* into the tube, and heat again; the one deposit, phosphates, entirely disappears, the other, albumen, becomes increased and consolidated.

Other tests for deposits: solubility in acetic acid, in liquor potassæ; insolubility in both acids and alkalies.

An approximate estimate of the whole quantity of lithic acid, or of phosphoric acid, excreted, beyond what is indicated by any deposit, should then be determined.

(b) For Foreign Constituents.—*Albumen*, note its absence or presence; and make an approximate calculation, from the quantity in a given measure of urine, of the whole quantity passed in twenty-four hours. *Sugar*, note its absence or presence; and similar approximate calculation of quantity. *Bile*, its absence or presence.

(3.) *Microscopic Examination*.—*Crystals*, note the absence or presence in the urine, or in any deposit; their shape, or other characters. Note *blood corpuscles*, *pus* and *mucus corpuscles*, *epithelial cells*, *uriniferous tubule*

casts, *spermatozoa*. Vegetable *parasitic* productions, or as engendered in decomposing or fermenting urine, *e. g.*, *penicillium glaucum* in non-saccharine urine; *torulæ cerevisiæ*, yeast-plant, in saccharine urine, when subjected to the fermentation test. Other foreign substances, *e. g.*, hairs, cotton fibres, from the towel used in examination, sputa, starch granules from admixture of food or tooth-powder, fæcal matter, particles of soot, sand, or dirt.

Appliances for Examination of Urine.—(1.)—*Chemical.* Certain simple chemical apparatus and tests will suffice for a clinical examination of the urine, and of its deposits.

The *apparatus* comprises—Urine glasses; a rather tall and deep receptacle suitable for immersion of the *urinometer* in taking the specific gravity of urine, and a glass graduated as a measure; test-tubes, in a half-dozen series, with stand, spirit-lamp, and well corked bottle of methylated spirit, slips or slides of glass, drop-tubes, and glass-stirring rods.

The *tests* ordinarily required are—acids: nitric acid fort., acetic acid; and alkalies: liquor potassæ, liquor ammoniæ fort. *Special* tests: sulphate of copper solution, or blue hydrated oxide of copper, or yeast for sugar-testing; sulphuric acid for bile testing.

(2.) *Clinical Microscope.*—Oberhauser's microscope is an instrument which I have been accustomed to use, with others, in the examination of the urine and its deposits. I have had the same instrument in use since the year 1853, a period of twenty-three years. The only inconveniences I have experienced in working it are,

that in altering the focus, or the field of vision, respectively, the requisite adjustment cannot be so readily commanded by the hand-movement of the tube, or the object, as it is by the screw-movements in other microscopes. But, unprovided with this additional mechanism for either such purpose, the price of the instrument is much less, an important consideration with regard to its general eligibility.*

Beale's clinical pocket microscope is a very simple, portable, and inexpensive instrument.

Object-glasses required for Clinical Examination.—Whatever form of microscope be preferred, the object-glasses, for magnifying the object to be examined, are the most essential requisite. The qualities of an object-glass consist in its magnifying power and achromatic character, by clearly defining the object, without any encircling play of colours. The powers most commonly useful in medical practice are two—the *quarter of an inch* focus, magnifying about 200 diameters, and the *inch*, magnifying about 30 to 50 diameters.

Microscope Lamp.—For examining objects by artificial light at night, or otherwise in the absence of daylight, some kind of illuminating contrivance will be necessary. An ordinary French lamp, provided with a blue glass chimney, may be used, or that recommended by Dr. Lionel Beale; a small paraffine lamp, with a round wick, may be preferred. But in the absence of any such lamp, a short wax candle, giving a clear white light, steadied by a screen, supplies a ready contrivance which will generally suffice.

* Oberhauser's Microscope and Object-glasses, &c., with Box, complete, £6.

Lithic or Uric Acid($C_{10}H_4N_4O_6$) *in Urine.**Diseases associated : *—*

Increased with	Diminished with
Dyspepsia.	Anæmia and chlorosis.
Gout.	Diabetes mellitus.
Nephritis, acute.	Nephritis, chronic.
Rheumatic fever.	
Disease of liver.	
Cirrhosis.	
Jaundice.	
Chronic diseases of stomach.	
Enlargement of spleen ?	
Ague.	
Leucocythemia.	
Pneumonia.	
Phthisis pulmonalis, acute.	
Ditto	chronic ?
Emphysema of lung.	
Ditto, with bronchitis.	
Capillary bronchitis, acute.	
Pleurisy.	
Disease of heart.	
Typhus fever.	
Typhoid ,,	
Scarlet ,,	
Small-pox.	
Eczema impetiginodes, acute.	
Epilepsy ?	

* "Diseases associated" with the various Morbid Conditions of the Urine are gathered from Dr. Hassall's elaborate work on the Urine.

General Symptoms.—They are those of gout, which may be taken as representing the lithic acid diathesis.

The premonitory symptoms refer to the digestive organs more especially, but also to the heart, lungs, brain, and perhaps other viscera. Dyspepsia, denoted by heartburn, eructations, acidity of the saliva, inappetency, and nausea. The bowels, distended with flatus, are irregular; urgent diarrhoea alternating with constipation. Pains dart about the body, and, with general restlessness and peevishness, there is much depression of spirits and gloomy apprehensiveness. Palpitations and shortness of breath evince the sympathy of the thoracic organs; while headache, with a swimming sensation, and sometimes a feeling of explosive fulness, are the accompanying cerebral symptoms.

A *fit* of the gout is manifested by inflammation attacking the joints, and very commonly the first joint, or ball, of the great toe. Commencing usually when the person about to suffer has retired, and has, perhaps, enjoyed some hours of sleep, he is awoken with pain in one of the feet, affecting the ball of the great toe, or, it may be, the heel, instep, or ankle. Cold shivering generally takes place, succeeded by heat, as the pain—boring, grinding, and wrenching—fastens more and more firmly on the spot of its choice. “Place your joint in a vice,” said a witty Frenchman, “and screw the instrument up until you can endure it no longer. That will represent rheumatism. Then give another twist, and you will somewhat realize gout.” The skin over this part is acutely tender, red, tense,

and shining, encircled by some swelling and by converging turgid veins. Much restlessness and excitement supervene. In vain the sufferer seeks to relieve himself of the weight of his bed-clothes upon the part inflamed, in vain he shifts his foot from place to place in search of a cool and easy position. The pain, remorseless, grapples yet more tightly. At length, in the course of twenty-four hours or so, it loosens its hold gradually, perhaps suddenly. The sleepless excitement also then subsides, and the victim enjoys some temporary repose. He wakes again to undergo punishment. The toe-screw is re-applied, it may be with a turn or two less ; and daily a slighter punishment is inflicted, until at length the full penalty has been paid. Then the cuticle peels off the part, for gouty inflammation ends in resolution, it never terminates by the effusion of lymph, suppuration, or gangrene.

Sometimes, having settled in the foot, it suddenly disappears, and migrates to the stomach—though this has been denied—to the heart or brain ; *retrocedent* gout, as it is then called, being, unlike the retreat of an ordinary foe, an assault on the very fortress of life. Less perilous migrations occur ; to the urethra, with a scalding discharge ; to the testicle, a form of orchitis ; to the eye, inducing ophthalmia.

The real decline of an attack is marked and measured by a flow of urine, surcharged with lithic acid, thus relieving its accumulation in the blood, and plainly declaring the nature of the disease. Irritability of the bladder at this time is often tormenting. Repeated attacks of gouty inflammation leave structural results

behind; the cellular texture around a joint becomes pervaded with a deposit of lithate of soda, forming concretions, at first pultaceous, then chalk-stones of perhaps considerable size. Hence the nodular toes and fingers of *chronic* gout. The skin over these nodules being stretched, at length breaks, and the chalky concretions are laid bare. Lithate of soda has been found infiltrating all the textures of one or several joints; in the synovial membrane, cartilage, heads of bone, and ligaments; and usurping their place, the articulations are irreparably destroyed.

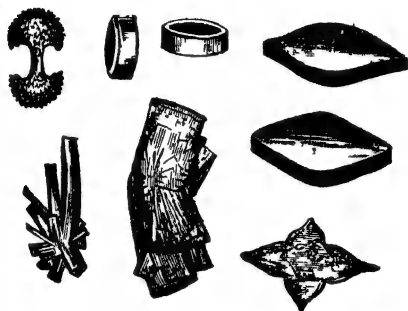
Physical Characters of Urine.—Clear, bright, golden or coppery colour, like brown sherry. Specific gravity increased. Quantity somewhat diminished. Acid reaction more decided, producing a deeper shade of red in blue litmus paper. A deposit of *yellow* or *red sand*, resembling particles of cayenne pepper,—lithic acid, sometimes in great abundance.

Diagnostic Value.—Lithic acid is eliminated from the blood, in combination with some base—soda, or ammonia more commonly, forming lithates of soda and ammonia. These salts, readily soluble in urine of the temperature of the body, are precipitated only when present in excess proportionately to the aqueous portion of urine secreted, and as the supersaturated solution cools. They then appear as *yellowish*, or *red brick-dust* deposits, which will be presently described. Lithic acid may, however, be liberated from these salts, by decomposition; but it occurs only when *some other* acid is present in *excess* to replace the acid in combination. Free lithic acid being insoluble, is then precipitated,

appearing as a deposit in the urine having the above characters.

Microscopical Characters.—This deposit consists of minute crystals, in various shapes, of which rhomboidal prisms are the most commonly characteristic. (Fig. 33.) Other forms are represented in Fig. 34.

FIG. 33.



Respecting the kind of acid by which uric acid is thus deposited, Parkes observes:* “It does not follow that the acidity should be owing to any single acid; it is owing either to an augmentation of all the usual acids of the urine—the sulphuric, phosphoric, and perhaps the hippuric, the lactic, and the carbonic—so that the bases are insufficient to neutralise them—or to the formation of acids after emission of the urine—viz., probably the lactic, acetic, butyric, or oxalic.

“It is of course, possible that the deposit of uric acid may be owing, not to excess of other acids, but to absolute deficiency of alkali: no facts have yet been discovered on this point.

* ‘Composition of the Urine, in Health and Disease, and under the action of Remedies,’ p. 218.

“The two causes of increased acidity of the urine—excess of normal acids, and formation of acid after

FIG. 34.



(Bowman.)

emission—are sometimes in simultaneous action. The urine depositing lithic acid without lithates is not

usually the high-coloured, red, pigment-loaded urine, but yellow and transparent; the acid is deposited slowly, and without admixture with lithates. Uroxanthin (indican) is often present in large quantity; and, as Virchow suggests, it may more rapidly form acid than common pigment."

The practical issue of all these considerations is this—that to rightly estimate the value of "lithic acid urine," as the sign of a corresponding "morbid blood-condition," it is necessary to discover the *total* amount of lithic acid excreted from time to time; and for this purpose we cannot trust any *deposit* thereof, either combined or free. The lithates may be in excess, *short* of a supersaturated solution; and lithic acid itself becomes apparent only when the urine is hyperacid from *other* causes.

Chemical Tests.—The over-acid reaction, as shown by blue litmus paper, has already been noticed.

A *deposit* of uric acid is insoluble in hot water, but soluble in alkalis—potash, soda, and ammonia.

A portion of the deposit is to be dissolved in a drop of potash. The alkaline solution is then to be treated with excess of acetic acid. In a few hours, crystals of uric acid will have formed, which can be identified by microscopic examination.

A portion of the deposit may be placed on a glass slide, and treated with a drop of strong nitric acid. Evaporate to dryness by a gentle heat, and expose the slide to the vapour of ammonia, or add a drop. A beautiful violet colour, from the formation of murexide, attests the presence of uric acid, or a urate. (L. Beale.)

The *total amount* of lithic acid excreted can be discovered by a simple experiment, devised by Golding Bird. Let all the urine passed in twenty-four hours be collected, well shaken, and a given quantity—say about two ounces—be mixed in a conical glass vessel, with about half a drachm of hydrochloric acid. In six or eight hours crystals of uric acid are copiously deposited on the sides of the glass. To ensure their complete separation, they should be allowed to repose for twenty-four hours, and may then be washed, dried, and weighed.* Simple multiplication shows the whole amount of uric acid secreted in the twenty-four hours, without the chance of any considerable error. In estimating the pathological importance of the result thus obtained, the healthy standard of quantity should be remembered, and this ranges from 6 to 10 grains of uric acid in twenty-four hours.

Urates or Lithates of Soda or Ammonia in Urine.

Diseases associated :—

The same diseases as with Lithic Acid Urine.

Physical Characters of Urine—Turbid in all cases on cooling and depositing lithates; the other characters of the urine vary, principally, with their colour. *White* lithates are deposited from a pale-coloured urine; specific gravity low; 1·010 to 1·014. The deposit is suspended, having a whitish flocculent cloudy appearance, which resembles mucus. *Fawn-coloured* lithates are deposited from an amber-coloured urine; specific gravity higher, but still lower than normal,

* 'Urinary Deposits,' ed. 4. See also 'Animal Chemistry,' &c., by Bence Jones, p. 53.

being about 1.018. *Red* brick-dust lithates are deposited from a yet deeper-coloured urine, and of higher specific gravity. *Purple* and *pink* lithates are deposited from a corresponding coloured urine, and of high specific gravity. The quantity of lithates secreted, and precipitated spontaneously, may not be equal. Hence the latter may not indicate the *whole* quantity. They are held in solution by urine of the ordinary temperature of the body, 98° ; but as the urine cools on exposure in the vessel used for its reception, the lithates are deposited. The proportion of water, as a constituent of urine, will also regulate the quantity deposited. These two conditions have been already noticed. But over-acidity of urine, owing to other acids in excess, allows an abundant deposit; whereas, a slightly acid or alkaline urine holds a proportion of the lithates in solution.

Microscopical Characters.—Amorphous granules is the usual appearance of lithate of ammonia, as seen under the microscope (Figs. 35 and 36), but certain forms of crystal are, occasionally, presented. Thus, spherules sometimes constricted in the middle, assuming a dumb-bell shape; or spherules with little claw-like projections (Figs. 36 and 37). Urate of soda is represented in Fig. 38. The junction of lithic acid-crystals gives rise to various singular appearances.

Chemical Tests.—Heat re-dissolves the lithates. Hot, not to say boiling, water poured into the chamber-utensil, causes the turbidity to disappear, and thus clears the urine. But this result may be partly due to the increased proportion of solvent—water, thus added

to a previously concentrated urine. A small quantity of the turbid urine heated in a test-tube becomes clear, but it again becomes turbid on cooling. The deeper-coloured urates are dissolved by a rather higher tem-

FIG 35.



FIG 36.



FIG 37.

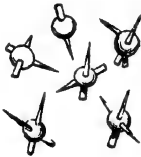


FIG 38.



perature than the paler varieties. Alkalies—potash or ammonia, dissolve these deposits; acids—hydrochloric or acetic, separate uric acid, having the appearance and crystalline forms already described.

A rough approximate analysis of the urates may be readily accomplished. The uric acid having been determined in a weighed portion of the dried urate by dilute hydrochloric acid, another portion of the urate

should be burnt, and, after washing the ash, tested with the blow-pipe. If the base be ammonia, a very small quantity of ash only will remain. For a full analysis of the urates, they should be previously examined with the microscope to ascertain whether they are free from phosphate of lime or magnesia, or oxalate of lime (Hassall).

Potash may be the most abundant base, next ammonia, and last soda. (Bence Jones.) *Lime* is always present in considerable quantity. (Hassall and Scherer.) *Magnesia* is an occasional base. (Robin and Verdeil).

It would, therefore, appear that the term *mixed* urates more accurately designates this deposit. The proportion of uric acid is always large—over 80 per cent. (Scherer); over 90 per cent. (Bence Jones).

Urea ($C_2H_4N_2O_2$) in Urine.

Diseases associated :—

Increased with	Diminished with
Acute pneumonia.	Epilepsy.
„ phthisis.	Acute yellow atrophy of liver.
„ capillary bronchitis.	Spasmodic asthma.
Pleurisy.	
Acute hepatitis.	Non-febrile icterus.
Rheumatic fever.	Acute gout.
Meningitis.	
Typhus fever.	
Typhoid „	
Scarlet „	

Increased with	Diminished with
Measles.	
Smallpox.	
Diabetes mellitus.	Diabetes insipidus.
Diuresis after dropsy.	
Nephritis, acute.	Nephritis, acute and chronic.
Ague, during fit.	Ague, after fit.
Acute eczema ?	

General Symptoms—are those of great muscular weakness and nervous exhaustion, with sometimes a dull aching pain across the loins ; a worn, anxious expression ; and, with diuresis, pallid emaciation, craving hunger and thirst. Irritability of the bladder is a marked symptom in all cases.

Physical Characters of Urine.—Excess of urea may occur, without diuresis,—the quantity of urine seldom exceeding the normal quantity, but the quantity of urea being both absolutely and relatively greater than in health ; or with diuresis,—the quantity of urine being excessive, and the quantity of urea, therefore, in a given specimen, less than in health, but the quantity, absolutely, and relatively to the other constituents, greater also, in this case, than normal. *Azoturia*, or unreal diabetes, as the latter may be termed, although differing only in degree, is a very rare disease.

The former condition of urine is, in colour, clear and pale, but occasionally assuming the appearance of porter diluted with water ; odour, not peculiar, but ammoniacal (apparently from decomposition of the urea) when not quite fresh ; specific gravity rather above the average, 1·020, but varying from 1·015 to

1.030, or even higher. Quantity about normal. Reaction acid, when the urine is fresh, but speedily becomes alkaline, from ammonia. A deposit of urea, in crystals, soon forms by evaporation, on the addition of nitric acid, forming the nitrate of urea.

Microscopical Characters.—Long needle-shaped crystals, by evaporating a drop or two of urine on a slip of glass. Nitrate and oxalate of urea also present crystals; the former in hexagonal plates and rhombic octohedræ (Fig. 39); the latter, in rectangular and

FIG. 39.

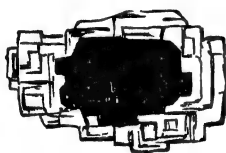


FIG. 40.



(Bowman.)

right rhombic prisms (Fig. 40), with a tendency to the formation of dumb-bell shaped oxalate of urea.

Chemical Tests.—Nitric acid added to a few drops of urine on a slip of glass, forms the nitrate of urea ($\text{C}_2\text{H}_4\text{N}_2\text{O}_2, \text{HO}, \text{NO}_5$), which, on evaporation, appears as a crust, more or less thick, according to the quantity of urea. Oxalate of urea ($\text{C}_2\text{H}_4\text{N}_2\text{O}_2, \text{HO}, \text{C}_2\text{O}_3$) is formed in like manner. Either compound can be verified by microscopical examination, while the chemical test indicates, approximately, the quantity of urea present.

Other tests are described in special works, but the above is the most ready method of detecting and determining urea.

*The separation of urea, in a free state, may be obtained from either the nitrate or oxalate, by the following simple process:—*Dissolve the oxalate of urea, for example, in hot water, and treat the solution with carbonate of lime, until effervescence ceases; the oxalate of lime thus formed, and any excess of the carbonate are precipitated, leaving the urea in solution. Carbonate of baryta may be used instead of the lime salt. Nitrate of urea may be decomposed in like manner. Crystals of nitrate of baryta are thrown down; the fluid is to be filtered, evaporated, and the residue extracted with ether.

Distinctive Characters of Urate of Soda, Earthy Phosphate, and Pus.—These three deposits are very similar in appearance, but have widely different pathological significance. Their certain and easy distinction is therefore of great practical importance. The following simple method of examination, and distinctive characters, are given by Dr Lionel Beale.

Let the urine stand in a conical glass for some time. Then pour off the clear supernatant fluid, and transfer a small portion of the deposit into a test-tube. Add about half the bulk of solution of potash, and observe:—

1. If urate of soda and ammonia, the potash may cause the mixture to become *clear*, but not viscid.

2. If entirely phosphate, *no change* will be produced.

3. If pus deposit, the mixture will become *clear*, and very *stringy* or viscid.

4. If both pus and phosphate be present, the mixture gelatinises, but does not become clear.

Microscopic examination will confirm this chemical test.

Phosphates in Urine.

Amorphous phosphate of lime—bone-earth ($3\text{CaO}, \text{PO}_5$).

Crystallised phosphate of lime ($2\text{CaO}, \text{HO}, \text{PO}_5 + 3\text{HO}$).

Phosphate of ammonia and magnesia—triple phosphate ($\text{NH}_4\text{O}, 2\text{MgO}, \text{PO}_5 + 12\text{HO}$).

Phosphate of soda ($2\text{NaO}, \text{HO}, \text{PO}_5 + 24\text{HO}$).

Acid phosphate of soda ($\text{NaO}, 2\text{HO}, \text{PO}_5 + 2\text{HO}$).

Diseases associated :—

Increased with	Diminished with
Meningitis.	Delirium tremens.
Acute mania, during parox.	Acute mania, in exhaustion.
Acute dementia, during paroxysm.	Acute dementia, in exhaustion.
Rickets.	Paralysis of insane, third stage.
Mollities ossium.	Acute gout.
Acute rheumatism.	Acute rheumatism.
Cholera early.	Cholera later.
Chronic phthisis ?	Pneumonia.
	* Bright's disease, acute and chronic.
	Typhus abdominalis.
	Pleurisy, acute ?
	Ague ?
	Diabetes ?

General Symptoms—consequent on an excess of phosphoric acid in the system, are those of exhaustion with irritability. Depression of spirits with irritability of temper; muscular weakness, and aching pains, especially across the loins, with perhaps a flickering endeavour to shake off debility, for such persons are not unfrequently intellectually active and energetic beyond their strength; these symptoms, with atonic flatulent dyspepsia, and sallow emaciation, as if consumption were in progress, complete the picture of the phosphatic diathesis. Irritability of the bladder is frequently very distressing.

Physical Characters of Urine.—Turbid in all cases, on depositing phosphates; of a pale yellow colour, if the deposition be occasioned by fixed alkali—potash or soda, and of an orange-brown colour, if occasioned by carbonate of ammonia—volatile alkali; the odour is ammoniacal, in the latter case; while the specific gravity varies greatly with the colour—the pale urine having a low specific gravity, the higher-coloured, a high specific gravity. The quantity is increased generally. The reaction varies—being alkaline or neutral, or slightly acid when first evacuated. The deposit of phosphates appears as a *white sand*, but generally combined with mucus, often present in large quantity, and pus, probably, in variable quantity.

Diagnostic Value.—Phosphatic urine, as ordinarily estimated by the amount of phosphates *deposited* in the urine, is deceptive. Phosphatic urine, in this sense, is only an appearance, not a true measure of the whole

amount of phosphates present, and of the pre-existing blood-condition.

The pathological significance of phosphatic deposits in the urine has been investigated more particularly by Dr Bence Jones.

Of *all* the phosphates *present*, not necessarily deposited, in the urine, those of soda are most abundant; equalling in amount three or four parts of the whole. The earthy phosphates of lime and magnesia represent the remainder. Phosphatic urine, therefore, should rather, of the two, have reference to the former salts. But the phosphates of soda are so very soluble in water and in acid or alkaline urine, that they are never deposited. In this respect resembling the sulphates of potash or soda, any excess of these phosphates remains concealed. On the contrary, the phosphates of lime and magnesia are scarcely soluble in water, and nearly insoluble in alkalies, although very soluble in acids, even in acid phosphate of soda. Therefore, whenever the urine becomes alkaline, down go the phosphates of lime and magnesia. This precipitate, however, denotes only the quantity of lime and magnesia drawn from the blood, and now appearing in the urine. The *major* portion of *phosphoric acid*, being combined with soda, remains unobserved.

By taking more lime or magnesia in the food, or by adding these bases to the urine, we increase the amount of earthy phosphates; and by a sufficiency, we precipitate *all* the phosphoric acid in combination with *them*, thus leaving no *phosphate* of soda in solution. Conversely, if we could abstract all the lime and

magnesia, no precipitate would appear by adding alkalis—in which, as well as acids, phosphate of soda is soluble,—though there remained a great excess of phosphate of soda concealed in solution. But if lime and magnesia are present, as usual, in the urine, a portion of the phosphoric acid appears in combination with them, forming a deposit of *these* phosphatic salts whenever the urine becomes *alkaline*, in which they are insoluble. Hence the more appropriate name, *alkaline* urine, suggested by Dr Bence Jones, rather than phosphatic urine, as ordinarily understood, which represents merely the amount of lime and magnesia present in combination with phosphoric acid. If regarded from this latter point of view, the term “phosphoric diathesis” should be extended to denote an increase in the *total* amount of phosphates, *alkaline* and earthy; or, if limited to one phosphate, it ought to denote *alkaline* phosphate, that being proportionately four or five times more abundant than earthy phosphates in the urine; moreover, the term earthy diathesis, as indicated by the urine, if used at all, ought to signify urine which really contains an *excess* of lime and magnesia, and not the precipitation, it may be of only a small quantity, of these earthy salts, the urine having lost its healthy property of retaining them in solution on becoming alkaline.

In short, alkalescence of the urine and increase in the *total* amount of phosphates have no relation of any kind to each other. They are quite distinct, and, indeed, rather opposite states.

Microscopical Characters.—Supposing *alkalinity* of

the urine be due to *fixed* alkali—as potash or soda—the phosphate of lime and the phosphate of magnesia are immediately deposited, appearing as a “white sand.” Submitted to microscopic examination, these salts are seen to consist of amorphous particles, or small round globules, and, occasionally only, prismatic crystals with oblique or dihedral summits (Fig. 41). According to Hassall’s observations,* crystallised phosphate of lime is common, much more so indeed than amorphous phosphate, which he regards as unusual.

This white deposit and coexisting alkaline condition of the urine occur whenever an excess of fixed alkali, or, what is equivalent, a deficient proportion of acid, is taken in the food. The urine is *secreted* alkaline, and deposits its earthy phosphates in greater or less abundance, according to the quantity of lime and magnesia present.

Not to be misled by an alkaline condition of the urine from *fixed* alkali, it is most important to know and remember that the acidity of *healthy* urine varies considerably during the diurnal period. According to the observations of Dr Bence Jones, confirmed by those of Dr W. Roberts, it is *inversely* to the acidity of the stomach. During digestion, when some acid, probably the hydrochloric, is being secreted by the stomach, an equivalent amount of soda or potash, previously in combination, must remain as free alkali in the blood, rendering it proportionately more and more alkaline. Accordingly, the urine becomes less and less acid, and perhaps eventually decidedly alkaline. When acid

* ‘Lancet,’ 850, vol. i; and ‘Med.-Chir. Trans.,’ vol. xxxvi.

ceases to flow into the stomach, and any superfluous portion which had been secreted is reabsorbed, the blood regains its former *average* degree of alkalescence; the urine also is secreted less and less alkaline, and becoming acid, its acidity rises until the next meal, when the highest degree of acidity is attained. If no food be taken, this condition of urine remains stationary for about twelve hours; immediately after a meal, its acidity again falls, and gradually approaches an alkaline reaction.* Examined at such time, alkalinity of urine might inadvertently be regarded as a morbid condition; but examination of another and another sample excreted some time after a meal, when the process of digestion is completed, corrects this suspicion; the urine thenceforth is found more and more acid prior to the next meal, when the alkaline retrogression supervenes.

This alternation of an alkaline state of the urine during digestion, and restoration of acidity on completion of digestion, invalidates the result of *any one* examination of the urine. A *mixed* sample of the whole amount of urine excreted during the twenty-four hours will give its average condition.

If *volatile* alkali—as carbonate of ammonia—be the occasion of alkaline urine, then the *deposit* consists of the ammoniaco-magnesian phosphate, together with some phosphate of lime; the former appearing in the form of transparent prismatic crystals, or of foliaceous, stellar, or penniform crystals (Fig. 41). The two latter

* See adverse observations by Dr Julius Vogel; 'A Guide to the Analysis of the Urine,' by C. Neubauer and J. Vogel, ed. 4. Translated for New Syd. Soc. by W. A. Markham, p. 296.

are phosphate of lime.* Other forms of *this* phosphate, are illustrated by Fig. 42.

FIG. 41.

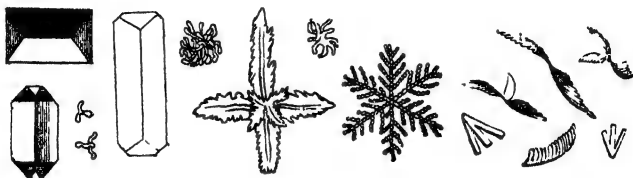
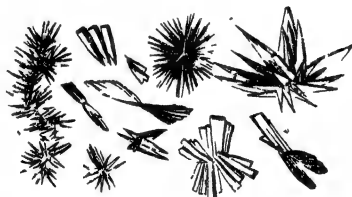


FIG. 42.



(Bowman.)

This deposit occurs whenever phosphates are deposited in connection with an inflamed state of the mucous membrane of the bladder, the ammonia being supplied by the decomposition of urea, which constituent of the urine may be regarded as carbonate of ammonia, plus two atoms of water. Whether urine is ever *secreted* ammoniacal appears doubtful; without doubt, however, it may become so, after emission, by decomposition of the urea. This source of the ammonia present in the phosphate, as then formed, was first clearly perceived by Lecanu, and has since been explicitly pointed out by Owen Rees. The decomposition of urea is effected

* 'Lancet,' 1853, Hassall.

apparently by the mucus, acting as a ferment, which is always more freely secreted by an inflamed mucous membrane, as in pyelitis and cystitis. Ammoniacomagnesian phosphate, consisting of its characteristic crystals, is abundantly deposited; and equally so, a white tenacious substance, that can be drawn into skeins of considerable length. It is said to consist of pus-globules, they having become adherent under the action of ammoniacal urine. The phosphate above mentioned, together with granules of phosphate of lime, are thus involved in one gelatinous mass. This mixed deposit is frequently witnessed in cases of paralysis affecting the bladder, a condition bordering on inflammation.

Chemical Tests.—All the phosphates are dissolved by acids—unlike coagulated albumen; and remain unaffected by heat—unlike the lithates; but the following points of contrast distinguish the two kinds of alkaline urine—the ammoniacal from that caused by fixed alkali.

Ammoniacal urine effects no change in blue litmus paper until it dries, when the pink colour immediately appears.* Urine becoming alkaline during digestion, *i. e.*, from *fixed* alkali, turns pink paper blue, which remains so when dry. *Ammoniacal* urine deposits crystals of phosphate of ammonia and magnesia, while urine otherwise alkaline, from *fixed* alkali, deposits an amorphous powder of phosphate of lime. The former deposit is associated with mucus and pus; the latter

* See 'Trans. of the Chemical Society,' vol. ii, p. 244, communication by Bence Jones.

with mucus only, and rarely in great quantity. *Ammoniacal* urine is constantly alkaline; that from fixed alkali is only occasionally alkaline, *i. e.*, at particular periods of the day. *Ammoniacal* urine is a sign of local disease—inflammation of the urinary mucous membrane; whereas alkalescence from *fixed* alkali is a sign of a more general disorder, *i. e.*, indigestion.

Guided by these characters, we can detect and discriminate the *kind* of alkali present in the urine, and its *source*. Yet such diagnosis, founded on the kind, and even the amount, of phosphatic salts *deposited* by the urine, signifies nothing concerning the *total* amount of phosphates *excreted from the blood*. The non-appearance of phosphates does not imply their absence, and their appearance is no measure of the total amount present. The question, therefore, an all-important one, presses; whether an *excess* of phosphates is accumulating in the “blood,” consequent on some perversion of nutrition or digestion, and constituting the true “phosphoric diathesis?” Mere inspection of the urine may disclose nothing respecting this constitutional morbid condition; and should the urine be alkaline, we then discover merely the amount of earthy bases—lime and magnesia, excreted in combination with phosphoric acid, and deposited. But this deposit of phosphoric salts contains only part of the whole phosphoric acid present. By far the greater portion remains concealed in the soluble phosphate of soda, which is never spontaneously precipitated under any circumstances.

To determine the *whole amount* of phosphoric acid eliminated, it is necessary to ascertain the amount of this

alkaline phosphate, as well as that of the earthy phosphates. Both together represent the phosphoric diathesis.

For this purpose the following experimental process is recommended by Bence Jones :—About 1000 grains of urine are to be weighed, and the earthy phosphates precipitated by pure ammonia, free from carbonate. These should be filtered, washed with ammoniacal water, and heated to redness ; adding at last a drop or two of nitric acid. The amount of earthy phosphates is determined by weighing the residue. The alkaline phosphates are estimated by taking about 500 grains of urine, adding an excess of chloride of calcium, and then pure ammonia. Thus all the phosphoric acid is precipitated as phosphate of lime. This is to be filtered, well washed, and the filter and the precipitate burnt with a drop or two of nitric acid. If the filtration has been slow, it is necessary to redissolve the residue in a platinum crucible by hydrochloric acid, and to re-precipitate by pure ammonia, when the filtration will take place very rapidly. After being burnt, the crucible is weighed, and by deducting the previously determined earthy phosphates, the difference may be taken as the amount of alkaline phosphate.*

Oxalate of Lime ($C_2O_3 + \frac{1}{2}CaO + 2HO$) in Urine.

Diseases associated :

Increased with

Dyspepsia.

Scrofula.

•

Gouty diathesis.

Rickets.

* See 'Phil. Trans.,' 1845, p. 365.

Increased with

Uric acid and urates in urine.	Emphysema of lung.
Cirrhosis of liver.	Emphysema of lung with
Jaundice.	phthisis.
Cholera, convalescence.	„ „ with bronchitis.
Bright's disease, chronic.	Spermatorrhœa.
Convalescence from severe	Pregnancy.
diseases.	Diabetes mellitus.
Many chronic diseases.	Epilepsy.

General Symptoms.—They are those of exhaustion with irritability. Depression of spirits, even to melancholy, with irritability of temper, often amounting to irascibility ; great muscular debility, with a severe and constant pain or sense of weight across the loins ; flatulent dyspepsia, well marked, and loss of flesh ; all these symptoms corresponding very much to the phosphatic diathesis. But the deeper tinge, so to speak, of the symptoms referred to, and the peculiar olive-greenish colour of the skin, almost stamp with characteristic distinction the oxalic-acid diathesis. Certain additional symptoms will aid the diagnosis. Feverish excitement, with dryness of the palms of the hands and soles of the feet, especially towards evening, may be notable in severe cases ; while the tendency to boils is of very frequent occurrence. Irritability of the bladder is, perhaps, equally frequent in either case, but the condition of the urine will at once determine the difference.

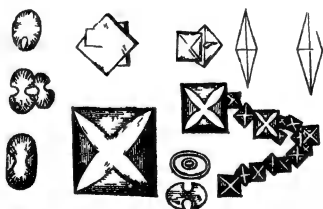
Physical Characters of Urine.—Clouded with much epithelium, and of a bright amber colour, somewhat resembling the bright golden sherry colour of lithic-acid urine ; but contrasting with the pale, whey-like

urine of earthy phosphates, and the turbid orange-brown of ammoniacal urine, which, moreover, presents an iridescent pellicle on its surface, and is ropy and fetid. The specific gravity varies extremely, from 1·015, or less, to 1·025, or more. Quantity of urine not much increased. Reaction decidedly acid. No deposit of oxalate, unless present in some quantity, and after some hours or days; then appearing as minute, colourless, transparent, hemp-seed concretions, mingled with mucus as a cloudy deposit.

On being heated, the urine may become gelatinous, yet retain its transparency.

Microscopical Characters.—Crystals in three forms: octohedra, the most common, or as dumb-bell shaped crystals; occasionally in the shape of small, red blood-globules, probably the earliest stage of dumb-bell oxalate. All these are here represented (Fig. 43).

FIG. 43.



Chemical Tests.—To determine the *whole* quantity of oxalic acid—free, or in combination with alkalies and soluble, or with lime, a portion of which oxalate may be precipitated—the urine of twenty-four hours must be collected. This should be evaporated to about one

fourth its bulk, neutralised with ammonia, be strongly acidulated with acetic acid to keep the phosphates dissolved, and then a solution of chloride of calcium added. The oxalate of lime thus formed is to be separated by filtration, dried, converted into either the carbonate or the sulphate in the usual manner, weighed, and the oxalic acid calculated from the resulting carbonate of sulphate. If there be any reason to suppose that the oxalate is mixed with uric acid, then dissolve in hydrochloric acid, filter, neutralize with ammonia, and again acidulate with acetic acid (Hassall).

Should any oxalate of lime have become deposited before examination, this may be either separated or redissolved.

To estimate the *diagnostic* importance of oxalate of lime in the urine, it should be remembered that this state is of very frequent occurrence, and its presence cannot be regarded as signifying a morbid blood-condition, excepting in respect of the *quantity* secreted. A few minute crystals are quite compatible with health; but large crystals in large quantity, and *persisting* for a considerable period, indicate such morbid condition.

The following observations by Golding Bird, respecting the composition of oxalic-acid urine, relate to the *circumstances* under which it occurs.

In rather more than one-third of the cases examined, uric acid or urates existed in large excess, forming the greater bulk of the existing deposit. In all there existed a greater proportion of urea than in healthy urine of the same density; and in nearly 30 per cent.

of the cases, so large a quantity of urea was present, that the fluid crystallized into a solid mass by adding nitric acid. The urate of ammonia found in the deposits of oxalic-acid urine is occasionally tinted with a pink hue. An excess of phosphate frequently accompanies the oxalate. The presence of sugar in the specimens examined was exceptional.

Prout regarded the oxalic-acid diathesis as a substitute for that of lithic acid, the former being preceded and followed by the latter. Liebig demonstrated the intimate relation of lithic acid to urea and oxalate of lime; the two latter having been formed artificially from the former; and this conversion of lithic acid was shown by Wöhler's experiments to take place in the bodies of animals.

Oxalic-acid urine—properly so called from the quantity of this acid excreted—is therefore an expression of *many* morbid conditions. Taking patients indiscriminately in a hospital, Bence Jones concludes that oxalate of lime is notably present in the urine in nearly one out of three. Diseases of many kinds, and of opposite characters, are apparently conducive to this result: indigestion, especially if attended with flatulence, and in cases also where no indigestion was ever experienced; skin diseases, and in cases where the skin was never affected; in acute rheumatism, acute gout, fever, and in diseases of women and children.

The generally more healthy state of the urinary organs in connection with oxalic acid urine, is an important consideration with reference to lithotomy or lithotrity.

*Sulphuric Acid (HO,SO₃) in Urine.**Diseases associated :—*

Increased with	Diminished with
Fever, simple.	Bright's disease, acute.
Rheumatic fever.	„ „ chronic.
Acute pneumonia.	Chronic diseases generally.
Pyæmia after confluent smallpox.	Jaundice without fever.
Delirium tremens.	Cholera.
Acute capillary bronchitis.	Anæmia and chlorosis.
Acute phthisis.	
Typhoid fever.	
Smallpox.	
Milk fever.	
Acute pleurisy.	
Chorea.	
Diabetes mellitus.	
Cholera.	
Anæmia and chlorosis.	

Physical Characters of Urine are not, apparently, peculiar, and therefore not distinctive. They would appear to resemble generally those of febrile urine. No deposit of sulphates ever occurs, they being soluble in urine—acid or alkaline—including ammoniacal urine.

Microscopical Characters.—Crystals of sulphates may be readily procured by evaporating a small quantity of urine on a slip of glass. The sulphate of *potash* then appears in the shape of short six-sided prisms, terminated by six-sided pyramids; but frequently the body

of the crystal is wanting, thus presenting a triangular-faced dodecahedron. Also in the shape of rosettes and dumb-bells (Fig. 44). Sulphate of *soda* appears as decahedral crystals.

FIG. 44.



Chemical Tests.—By adding a soluble salt of baryta, *e.g.*, chloride of barium, the sulphate of baryta formed is insoluble and conspicuous, thus representing the sulphuric acid present; but not discovered by merely inspecting the urine, in which the sulphates of potash and soda are absolutely soluble, whether the urine be itself acid or alkaline. The readiness with which the insoluble baryta sulphate appears will show the excess of sulphuric acid.

The *whole* quantity of sulphuric acid present may be determined as proposed by Dr Bence Jones :—about 500 grains of urine are weighed, and chloride of barium is then added in excess, a few drops of hydrochloric or nitric acid being used to ensure the solution of the phosphate of baryta. Heat is applied, and the liquid boiled for a few minutes briskly. The sulphate of baryta is filtered and washed until the clear liquid

is perfectly free from chloride of barium. The filter is burnt, and the residue weighed. The amount of sulphate of baryta in a known quantity of urine is thus determined, and the whole amount in twenty-four hours can be calculated.

Diagnostic Value.—The interpretation of sulphuric acid in the urine is somewhat parallel to that of phosphoric acid. The quantity of either acid present absolutely and relatively to the other urinary constituents, is the question with reference to the blood-condition. Unlike phosphoric acid, *no part* of the sulphuric acid is ever deposited in combination, *i.e.*, as sulphates of potash and soda; they being the only sulphates (excepting, perhaps, a little lime sulphate), completely soluble in any urine, even alkaline urine. But the greater part—about three fourths of the whole of the phosphoric acid—is in combination with these alkaline bases, and these phosphates are also completely soluble in any urine, and never deposited. While, therefore, mere inspection of the urine overlooks the greater portion of the phosphoric acid present, it discovers none of the sulphuric acid. On the other hand, the remaining small portion of phosphoric acid in combination with the earthy bases, lime and magnesia, being insoluble only in alkaline urine, their precipitation indicates and measures only the alkalescence of the urine,—by fixed alkali potash or soda, or the volatile alkali ammonia. Not even this chemical condition of the urine is discoverable through the sulphates, which never appear.

Chemical examination of the urine—as already de-

scribed—by the formation of the sulphate of baryta, which is insoluble, and deposited accordingly, will discover the presence of sulphuric acid, and its whole amount.

Hippuric acid ($\text{HO}, \text{C}_{18}\text{HNO}_5$) *in Urine.*

Diseases associated :—

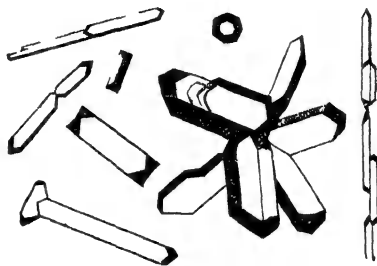
Increased with	Diminished with
Liver disease, <i>e.g.</i> , cirrhosis.	Jaundice, absent.
Dyspepsia, atonic.	Typhus fever.
Cholera.	Pneumonia ?
Chorea.	
Diabetes mellitus.	
„ insipidus.	

The General Symptoms are those of muscular weakness and nervous exhaustion, consequent, it would seem, on the deprivation of nitrogenous food and an excess of carbonaceous matter in the system. The accompanying condition of urine will, however, as usual, determine the diagnosis between this and other diseases, *e.g.*, excess of urea, phosphates, or oxalates, which present similar general symptoms.

Physical Characters of Urine.—The colour varies—pale, or, it may be, resembles that of febrile urine; the odour is generally like that of whey; specific gravity below rather than above the healthy average—1·020, and in one case (by Bouchardat) it varied from 1·006 to 1·008. Quantity copious. Reaction, generally, very faintly acid, neutral, or alkaline. A deposit of triple phosphate of magnesia not unfrequently occurs.

Microscopical Characters.—Crystals of the oblique rhomboidal prism, and its modifications, are obtained by evaporating two or three drops of fresh urine, to which a little hydrochloric acid has been added, on a slip of glass (Fig. 45). In stale urine, the hippuric

FIG. 45.



will be found converted into benzoic acid; but its crystals, obtained in like manner, are characteristically different—thin glistening scales.

Other forms of hippuric acid are here represented (Fig. 46).

FIG. 46.



(Bowman)

Chemical Tests.—Neutralize the acid with lime, concentrate by evaporation, add hydrochloric acid, in a flask, to decompose the hippurate of lime; introduce

ether in large quantity, and cork the flask, agitate from time to time, pour off the ethereal solution which floats on the surface, wash it with water to remove traces of hydrochloric acid, and then evaporate to obtain the free hippuric acid.

If the ether should not separate readily from the mixture, add a very small quantity of alcohol; the water added removes the latter, and any urea in solution, as well as the hydrochloric acid.

Lactic Acid ($\text{HO}, \text{C}_6\text{H}_5\text{O}_5$) *in Urine.*

Diseases associated :—

Increased with

Febrile diseases.	Osteomalacia.
Recurrent catarrh.	Pyæmia.
Oxalate of lime and uric acid.	Leucæmia.
Diabetes mellitus.	Puerperal fever.
Rachitis.	Rheumatism ?

Physical Characters of Urine.—Not distinctive.

Microscopical Characters.—Crystals of the lactates of zinc, lime, and copper, may be obtained, which are characteristic; the former especially, being thick rhombic tablets in clusters, and those of lime having the appearance of double brushes.

Chemical Tests.—Evaporate fresh urine to the thickness of syrup, by means of a low temperature with the water-bath, treat the residue with alcohol holding oxalic acid in solution, treat the alcoholic extract with an excess of hydrated oxide of lead, filter the solution, remove the excess of lead by sulphuretted hydrogen,

boil the filtrate with oxide of zinc, filter again and evaporate to concentration, and lactate of zinc will appear with its characteristic crystals.

Lactate of lime may be formed by first procuring a solution of lactate of baryta, and then decomposing with sulphate of lime.

Or, the lactate of copper, from that of lime, by adding sulphate of copper.

Chlorides in Urine.

Chloride of sodium (NaCl).

Chloride of potassium (KCl).

Chloride of ammonium (NH_4Cl).

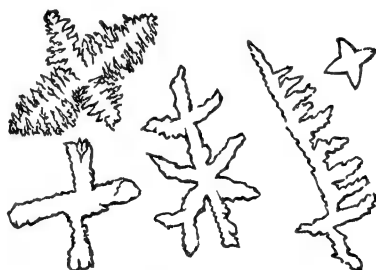
Diseases associated :

Increased with	Diminished with
Diabetes mellitus.	Acute pneumonia.
Ague—cold and hot stages.	Acute pulmonary phthisis.
Chronic phthisis.	Acute capillary bronchitis.
Hot stage, and beginning of sweating.	Pleurisy.
	Acute rheumatism.
	Typhus fever.
	Typhoid fever.
	Scarlet fever.
	Erysipelas.
	Puerperal fever.
	Milk fever.
	Chronic febrile diseases.
	Chlorea.
	Dropsy—cardiac, hepatic.
	Bright's disease—acute and chronic,

Physical Characters of Urine.—Not distinctive.

Microscopical Characters.—The chlorine is, for the most part, in combination with sodium, and the chloride of sodium readily crystallizes. By evaporating a drop or two of urine on a slip of glass, crystals are obtained in the octohedral form, distinguished from those of oxalate of lime by their principal axis being longer, and by not polarizing light. Half-octohedra, which are occasionally striated, is another form. Dodecahedra, or twelve-sided crystals, are the rarest form. By evaporation also, or from a solution of the ash of urine, the salt often crystallizes in the form of crosslets and daggers (Fig. 47).

FIG. 47.



Chemical Tests.—Nitrate of silver, in solution, is a handy test for the presence, or qualitative determination, of chloride of sodium, in urine. One caution only is required: to strongly acidulate the urine with nitric acid, in order to prevent the precipitation of phosphate of silver; or the nitric acid may be added after the nitrate of silver, when any phosphate of silver will be immediately dissolved (Thudichum).

The quantity may be determined, either by weighing the white precipitate—chloride of silver; or volumetrically, by noting the quantity of a solution of nitrate of silver, of known and appropriate strength, required to separate the whole of the chlorine.

Sugar ($C_{12}H_{12}O_{12}$) in Urine.

Diseases associated :—

Diabetes mellitus.	Hysteria ?
Dyspepsia.	Epilepsy ?
Gout.	Asthma ?
Injuries of head.	Emphysema, pulmonary ?
Cholera.	Phthisis ?
Hypochondriasis.	Acute pneumonia—sputa ?
Urine of old persons.	Hooping-cough—after ?
After chloroform of 24 hours' administration.	
Pregnancy and lactation.	
Lactation with suppression.	

General Symptoms of Diabetes Mellitus—Mellituria—Glucosuria.—Approaching insidiously, the quantity of urine becomes notably increased, owing to the diuretic action of sugar : micturition, also, is more frequent and urgent, from the presence of sugar in the urine secreted, and thus irritability of the bladder is established. This constant drain of water through the kidneys is necessarily attended with a diminished discharge through other channels; hence dryness and roughness of the skin, the cuticle powdering off, constipation, a pasty

tongue, not unfrequently red, unquenchable thirst, craving hunger, with progressive emaciation, partly due to actual wasting, partly to the drying up of the body consequent on the incessant renal discharge of water from the system. Debility progressively accompanies this wasting and mummification, yet the mind remains unclouded to the last.

Diabetes mellitus is the expression sometimes used for that disease whereof sugar in the urine is the sign; and this attributive title seems necessary to distinguish ordinary diabetes from a variety contra-designated *Diabetes insipidus*. In the former, farinaceous matters are probably converted into dextrin, and thence at once into grape-sugar; but there is some reason to believe that this succession of metamorphoses may be interrupted, and that an *insipid* sugar is then formed immediately between dextrin and sugar of milk (Bence Jones). This tasteless sugar resembles sugar of milk, differing from it in not giving rise to mucic acid and in undergoing fermentation. It can be converted into grape-sugar by the action of acids.

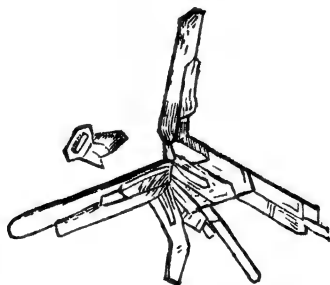
Diabetes insipidus has received other names—*Polydipsia* (Becquerel), *Diuresis* and *Hydruria* (Willis). The secretion thus signified, of a large quantity of *watery* urine, is probably a distinct disease. Aqueous diabetes commonly occurs in connection with hysteria; and the term *hydruria* distinguishes it from *azoturia*, of which disease an excessive excretion of *urea* is the prevailing characteristic. The absolute amount of *urea* excreted in the twenty-four hours may be increased in *hydruria*; no sample, however, of such

urine contains its normal proportion to the water secreted.

Physical Characters of Urine.—Clear, pale-straw, or greenish tint, sweet smell and taste; specific gravity high, averaging 1.040, and the quantity much increased, to 100 ounces, or even 400 ounces, in twenty-four hours. A crystalline deposit of sugar readily forms as an efflorescence on any clothing or other surface where the urine may happen to dry. The reaction is acid, but neutral or slightly alkaline if the quantity of sugar be small and the urine fresh.

Microscopical Characters.—Crystals in the shape of rhombic plates, six-sided, aggregated into roundish granules, or as single plates (Fig. 48).

FIG. 48.



Chemical Tests.—The composition of diabetic urine is peculiar in containing a *foreign* ingredient—glucose, or sugar of the grape, and which is excreted, possibly, in quantity varying from 1 lb. to 2 lbs. or more, in twenty-four hours; whereby a patient may pass more than his

own weight of sugar in the course of a few months. The urine contains, also, usually rather more than less of its ordinary constituents.

Diagnostic Value.—Saccharine matter is occasionally present, and as a mere trace, in healthy urine; but any more obvious quantity, and *persistent*, is abnormal.

To estimate the pathological significance of diabetic urine, therefore, the constant presence of sugar in any notable quantity, rather than its absolute amount, is the diagnostic sign of consequence.

. To detect this morbid condition in its infancy—indicating a corresponding blood-condition—certain tests, more delicate even than the production of the rhombic crystals, can be applied with signal success.

Yeast or Fermentation Test :—This is easily applied. Add a small quantity of yeast to some of the suspected urine in a saucer; invert a test-tube filled with this mixture, and stand it in the saucer; then place the whole in a warm room. If sugar be present, fermentation soon begins, and bubbles of carbonic acid rising in the tube accumulate and depress the fluid. Minute fungoid growths also are developed, which can be seen with the aid of the microscope. Another fungus—*penicilium glaucum*—(Fig. 49, to left) the mildew that over-spreads decaying vegetable or animal matter, and which may appear in *non-saccharine* urine, is apt to be mistaken for this “yeast-plant”—*torula cerevisiæ* (Fig. 49, to right). Their distinctive microscopic characters were pointed out by Dr. Hassall.*

Certain *chemical* tests are more conclusive. They

* ‘The Urine in Health and Disease,’ pp. 149—151.

all depend on the facility with which the composition of diabetic sugar is changed; and this can be readily effected by salts of copper, and by alkalies.* Full

FIG 49.



directions for the successful application of these tests are given in Golding Bird's work;† the following particulars, however, are essential to our purpose—the early and exact detection and discrimination of diabetic urine:—

Copper, or Trommer's Test.—Add to the suspected urine in a large test-tube just enough of a solution of sulphate of copper to communicate a faint blue tint. A slight deposit of phosphate of copper generally falls. Liquor potassæ must then be added in great excess; a precipitate of hydrated oxide of copper first falls, which redissolves in the excess of alkali, if sugar be present, forming a blue solution like ammoniuret of copper. On gently heating the mixture to ebullition, a deposit of red suboxide of copper falls, if sugar be present.

* See 'Med.-Chir. Review,' January, 1853. Lionel Beale.

† 'Urinary Deposits.' Edit. by Dr. Birkett.

Cappezzuoli's Test.—Add a few grains of blue hydrated oxide of copper to urine in a conical glass vessel, and render the whole alkaline by adding liquor potassæ. If sugar be present, the fluid assumes a reddish colour, and in a few hours the edge of the oxide deposit acquires a yellow colour, which gradually extends through the mass, owing to the reduction of the oxide to a metallic state (suboxide?).

Potash or Moore's Test.—Place in a test-tube about two drachms of the suspected urine, and add nearly half its bulk of liquor potassæ. Heat the whole over a spirit-lamp, and allow active ebullition to continue for a minute or two; the previously pale urine will become of an orange-brown or even a bistre tint, according to the proportion of sugar present. The subsequent addition of an acid generally causes the evolution of an odour of boiling molasses. Should the liquor potassæ contain lead, a dark colour is produced by the sulphur in the urinary excretion acting on it, which might lead one to suspect the presence of sugar when none exists—a source of error first pointed out by Dr Owen Rees. Hence it is important to preserve the test-solution in bottles of green glass free from lead.

For Traces only of Sugar.—Certain tests are appropriate for the detection of sugar, when present in otherwise unappreciable small quantity—as a mere trace. The application of such tests implies the previous separation of some of the other constituents, which would interfere with their action.

(a) *Brücke's Test.*—Add to the suspected urine,

neutral acetate of lead, and afterwards basic acetate of lead. Separate the precipitate by filtration, and add ammonia to the solution. The precipitate, by ammonia, is decomposed by oxalic acid, or suspended in water, and sulphuretted hydrogen passed through it. The filtered solution contains the sugar, which can then be detected by any of the tests already described.

This process will detect the seventh of a grain of sugar, diluted with more than six ounces of water; and two-thirds of the whole quantity of sugar present in a solution can be separated.

(b) *Maumene's Test*.—Soak strips of woollen rag in a solution of perchloride of tin—one part of perchloride to two parts of water—for four or five minutes. Dry the slips over a water-bath. Let fall a drop of the suspected urine on one of these prepared strips, dry it, and expose to the dull red heat of a spirit-lamp. If only a trace of sugar be present, a black spot appears.

(c) *Chromate of Potash Test*.—Mix equal parts of neutral chromate of potash and solution of potash with the suspected urine, and boil; if sugar be present, a green colour, by the formation of oxide of chromium, is produced. (Horsley.) A modification of this test may be made: a solution of bichromate of potash is decomposed by excess of sulphuric acid; mix this with the urine, and boil; a beautiful green colour appears. This reaction is not affected by urea, the urates, or albumen. (Luton.)

To Estimate the Quantity of Sugar.—By the *Fermentation Test*, the quantity of sugar present in diabetic

urine, may be estimated according to either of two of the results of this process:—

(a) *By measuring the volume of Carbonic Acid produced.*—The mixture of yeast and urine is placed in a graduated tube, inverted over mercury. When the fermentation is finished, in from six to twelve hours, at a temperature of 100° Fahr., the volume of gas formed is thus indicated, and subject to correction for temperature and pressure, the amount of sugar can be calculated. One cubic inch of carbonic acid represents nearly one grain of sugar.

(b) *By the diminution in specific gravity or weight of the urine, after destruction of the sugar by complete fermentation; as compared with the weight before this process*—Dr W. Roberts' method. The difference of specific gravity here indicates the quantity of sugar. Two portions of urine, of four ounces each, are placed in separate bottles of about twelve ounces capacity. In one is placed a piece of German yeast, the other is tightly corked. Both are placed in a warm place for twenty-two hours, until fermentation is complete. The bottles are removed to a cooler locality, and after two hours the density of the fluid in each bottle is tested by the urinometer. Every degree of density lost, by the fermented sample, indicates one grain of sugar in each fluid ounce of urine.

Albumen in Urine—Albuminuria.

Diseases associated:—

Bright's disease, acute	Rheumatism, acute.
and chronic.	„ subacute.

Scarlatina.	Pregnancy.
Disease of heart.	Intermittent fever.
Cholera.	Measles.
Diarrhœa.	Smallpox.
Puerperal convulsions.	Peritonitis.
„ fever.	Pleurisy.
Typhoid fever.	Erysipelas.
Typhus fever.	Paralysis.
Pneumonia.	Purpura.
Bronchitis.	Diseases with blood in
Phthisis.	urine.

General Symptoms of Bright's disease of the kidneys.—Certain structural changes in the kidney are the immediate causes of the symptoms. These changes are : congestion, — the kidneys being enlarged by engorgement of blood, and having a deep purple colour ; followed by interstitial effusion, affecting chiefly the cortical or secreting portion of the gland, with enlargement, pale colour, and moderately firm consistence : degeneration, — fatty or waxy (amyloid) degeneration of the effused matter, with some physical alterations of colour and consistence : or, lastly, partial absorption and contraction, — producing a small, firm, remnant kidney, having an irregular puckered surface, and granular aspect when the adherent capsule is withdrawn, — granular degeneration.

The first of these conditions has been named by Dr G. Johnson acute desquamative nephritis, — fibrinous casts of the uriniferous tubules, with epithelial cells, coming away in the urine ; the second, chronic non-

desquamative nephritis ; while the third condition might be termed the atrophied or remnant kidney.

Whether we regard these structural changes as a consequential series, or as so many independent forms of renal disease, they are one and all included under the title—Bright's disease,—for with each, albuminous urine is invariably connected.

The symptoms incident to each of these alterations of structure necessarily vary, yet they are substantially the same.

Congestion of the kidneys, beginning with pain or weight in the loins, sickness, and general febrile disturbance, is accompanied with albuminous urine, and the retention of urea and water in the blood, with its effusion into the cellular texture generally : thus constituting “febrile dropsy.” The blood and urine have, in respect to each of their prominent constituents, albumen and urea, changed places. While, therefore, the nutrition of the body is undermined by the constant abstraction of the one, the system, through the blood, is poisoned by the retention of the other. Hence the symptoms of uræmia, which are of a typhoid character, and prominently those of “febrile oppression ;” the functions of the nervous system being overwhelmed, as by intoxication, and stupor or coma induced. Urea in the circulation may affect various organs, giving rise to particular symptoms. Meningitis with its symptoms, or those of cerebral irritation only, as headache, convulsions ; pleurisy, pericarditis, or peritonitis ; irritation of the bronchial, or of the gastro-intestinal mucous membranes. Add to which

degeneration of other organs, especially the heart, liver, and vessels of the brain, is not unfrequently a coexisting or consequential condition, thus giving rise to *their* additional symptoms. Dropsy, owing to the concomitant retention of water in the blood, may be called an accidental symptom.

The same essential symptoms of Bright's disease of the kidneys, are connected also with the alterations of *structure* which occur in consequence, or perhaps independently, of congestion; but the albumen returns to the blood, and the water, about proportionately, to the urine, the urea and other solid urinary constituents being still retained in a progressively greater proportion in the blood; thus reducing the urine to a mere discharge of water, and often in great quantity. The scanty secretion of urine during congestion, contrasts with this diuresis-anazoturia. • Micturition is more frequent, and perhaps urgent, in the one case, and more abundant in the other. In both, irritability of the bladder is excited by the unaccustomed urine.

Physical Characters of Urine, in Bright's disease.— Colour, smoky-brown; easily froths, owing to the presence of albumen; specific gravity low, averaging 1·014, by abstraction of the urea; quantity of urine much diminished, owing to the reduced proportion of water. Subsequently, the urine becomes pale and opalescent, and is less apt to froth, there being much less albumen: the specific gravity declines yet lower, down perhaps to 1·004, while the quantity of urine is increased, approaching even to diuresis. The reaction is, generally, much less acid than in health.

The specific gravity of the serum of the blood is reduced to 1·018 or even to 1·015, as compared with that in health, which ranges between 1·029 and 1·031.

Microscopical Characters.—Casts of the uriniferous tubules, blood, and perhaps pus, may pass in the urine, which presents accordingly characteristic appearances under the microscope (Fig. 50); but their descrip-

FIG. 50.

tion scarcely relates to the composition of the urine secreted.

Chemical Tests.—The solid constituents of the urine, amounting in health to about 68 in 1000 of urine, in Bright's disease declines to 14, 12, or even 6 parts only in 1000. This is chiefly due to the abstraction of urea, alluded to in connection with the altered physical characters of the urine. The quantity of albumen contained in the urine varies exceedingly; from a mere trace, to possibly 545 grs. in the twenty-four hours. (Parkes.)

The presence, or, as in the early stage it might be termed, the substitution of albumen for urea, is easily discovered and readily distinguished, provided only certain precautions be observed in making the examination.

They relate either to the chemical composition of the urine submitted to examination, or to the tests

employed; chiefly, these precautions have reference to the urine itself.

Albuminous urine is not merely a solution of albumen. So far as it *alone* is concerned, by applying heat to such urine, the albuminous portion—white of egg—begins to coagulate at 160° Fahr., and gradually solidifies as the temperature rises to 212°. But this urine contains other ingredients, and their variations in quantity interfere with the coagulation of the albumen.

Thus, if the urine be alkaline, or even neutral,—whether from the presence of volatile alkali, carbonate of ammonia, or from fixed alkali, as soda, either alkali will combine with albumen, and neither of the resulting compounds being coagulable by heat, the urine remains clear when heat is applied. The albumen is not discovered, although perhaps abundant. Or again, if an opposite condition exists,—should the urine be over acid, from the presence of a free acid, as the acetic or hydrochloric, the acid will combine with albumen, and the acetate and hydrochlorate of albumen being uncoagulable by heat, the urine remains clear when heated. The albumen is concealed.

Supposing, however, that, on the application of heat, a white flaky precipitate does fall, resembling albumen, it may not be albumen. * Earthy phosphates are likewise precipitated by heat. To distinguish between these two deposits—phosphates and coagulated albumen, as well as to evolve albumen concealed by an alkaline or over-acid state of the urine—heat having been applied, nitric acid (strong) should then be

dropped into the test-tube, containing supposed albuminous urine. If the deposit be phosphates, they are redissolved; if albumen, it is more firmly coagulated.

Nitric acid *unaided* will precipitate albumen, but it also liberates lithic acid from the lithates, and combines with urea; when, therefore, either of these constituents is present in excess, a brown deposit of lithic acid or nitrate of urea forms and disguises the albumen. Both precipitates, however, together with the lithates, are redissolved by heat, which on the contrary, discloses albumen.

In short, *heat* clears off any difficulty arising from lithic acid, the lithates, and urea; *nitric acid* clears off any difficulty arising from the (earthy) phosphates, at the same time liberating and evolving albumen from any prevailing alkaline or mineral acid condition.

Nitric acid, in respect of its behaviour to albumen, disputes with heat the privilege of disclosing the presence of this abnormal constituent of urine. Nitric acid unites with albumen, forming what may be called nitrate of albumen, which is not coagulable by heat. Consequently, if only just so much acid be added to albuminous urine as shall combine with all the albumen present, and form this nitrate, none of the albumen will appear when heated. Nitrate of albumen being *insoluble* in nitric acid, appears when *more* acid is added; but is again redissolved on the addition of an *excess* of acid. The happy *medium* quantity of acid is necessary to exhibit albumen,—not just an equivalent, which combining with the whole amount present,

renders it insoluble, although heated; this would be too small a proportion of acid; while an excess—above that proportion in which the nitrate of albumen is insoluble—redissolves it.

To strike the balance, and moreover obviate all other possible difficulties to which I have referred, the right method of examining supposed albuminous urine is simply this:—Pour a *small* quantity—say a fluid drachm—of the urine into a test-tube; heat it to the boiling point, and then drop in *two* or *three* drops only of strong nitric acid. If phosphates have been precipitated by the heat applied, they will be redissolved, and the white flakes of coagulated albumen appear more clearly. On being allowed to stand, it will subside in the tube, leaving the urine above clear; thus defining the quantity of albumen present in any given quantity of urine examined. This will be found, as already said, to vary between two extremes; a slight white cloudiness subsiding as a little flaky deposit, or part or the whole sample becoming solid and white, like coagulated albumen of an egg, in the tube.

To exactly estimate the quantity of albumen.—Either of the two following processes may be resorted to:—

Take 500 grs. of the urine of twenty-four hours, and boil it in a flask, nitric acid being added subsequently, to secure coagulation of the albumen, and to dissolve any of the phosphates deposited by boiling. Then let the coagulated albumen subside by standing the flask, decant off the clear fluid, and throw the residue upon a weighed filter. Wash the col-

lected albumen on the filter, with hot distilled water, to bring away saline matter; dry on the water-bath, and weigh.

Or, acetic acid may be added, in just sufficient quantity, and the urine boiled, thus to effect coagulation. The process is then concluded in like manner.

Diagnostic Value.—The significance of albuminous urine is its *persistence*, which is pathognomonic of Bright's disease of the kidney. With rare exceptions, this disease is invariably accompanied with albuminous urine, and this condition of urine persisting is a sure sign of that disease, and of no other.

Temporarily, albuminous urine is associated with many other diseases, most of which are specified in the table.

Bile in Urine.

Diseases associated:—

Jaundice from obstruction.	Smallpox.
Acute Hepatitis.	Scarlet fever.
Cirrhosis of liver.	Puerperal fever.
Acute yellow Atrophy.	Pyæmia.
Pneumonia.	Urine in hot weather.
	Urine of Pregnancy.

General Symptoms of Jaundice.—Certain structural changes in the liver are the immediate causes of the symptoms. These changes are:—some *mechanical* impediment, which, precluding a free flow of bile into the duodenum, permits absorption of the bile imprisoned. The obstacle in question may be constriction, or closure of—as by a gall-stone impacted in—

the common bile-duct, the hepatic duct, the cystic duct, or of the bile-ducts within the liver;* or the impediment may be due to some external cause of pressure on either of the ducts, as by thickening of the pylorus, duodenum, or head of the pancreas; or a tumour within the liver itself, overlaying the ducts. Without any obvious mechanical impediment to the free escape of bile, *suppression of its secretion* is more frequently the occasion of deficient elimination of bile. Structural disease of the liver, *e.g.*, inflammation, acute and chronic, cirrhosis, fatty degeneration, operates in this way. So, also, various blood-poisons, *e.g.*, through snake-bites, pyæmic infection of the blood, typhus, and malaria, intermittent, remittent, and yellow fever, severally give rise to jaundice. Ether and chloroform, likewise, are said to occasionally have this effect. In all these cases the liver itself may be structurally healthy; the blood-poison alone is the cause of a suppressed secretion of bile, which, in turn, reacting upon the blood, induces jaundice. Similarly, through the nervous system, mental emotions have, in some cases, paralysed the liver, and produced this disease.

The symptoms of each of these causative conditions are those of jaundice—a yellow or yellowish-green discolouration of the skin and conjunctivæ, and of the urine, with light drab-coloured fæces. These appearances are due to the presence or absence of biliary colouring matters. The retention of bile in the blood circu-

* 'Diseases of the Liver,' Frerichs. Translated by C. Murchison, M.D. Vol. I.

lating is, like urea, sedative to the vital powers of the nervous and muscular systems, irritative in its operation on certain parts, locally. Hypochondriacal depression, weariness, and great weakness, are not unfrequently accompanied with an intolerable itching of the skin, and irritability of the urinary bladder, as biliary colouring-matter escapes by the urine. The want of bile in the small intestine renders the process of digestion incomplete; and the inappetency or even loathing of food occasioned by the bile retained in the system, is accompanied with imperfect chylication of the scanty ingesta, and the separation of pale yellow faecal matter; while habitual constipation is relieved by occasional colicky diarrhoea. Progressive emaciation necessarily follows this constant starvation; and the withered, discoloured appearance of the individual, melancholy, exhausted, and dyspeptic, cannot fail to convey the impression of jaundice. Examination of the urine will at once settle the question.

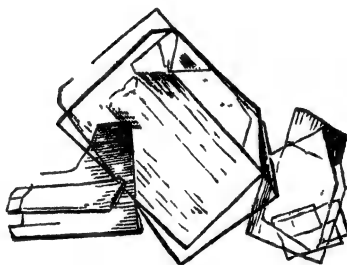
The passage of a gall-stone is attended with paroxysmal pain in the epigastrium, always severe, sometimes excruciating, according to the size of the stone *in transitu*, hiccup, vomiting, and constitutional disturbance; but, in general, inflammation and its symptomatic fever do not supervene.

Physical Characters of Urine.—Colour, dark saffron, green or black; leaving a bright yellow, or other stain, on white linen. Other characters are not peculiar.

Microscopical Characters.—Certain constituents of the bile, when present in urine, may be obtained in crystalline forms. Taurine, as regular hexagonal

prisms, with four or six-sided sharp extremities, the elementary form being a right rhombic prism. Crystals of cholesterine may also be found. (Fig. 51.)

FIG. 51.



Chemical Tests—are the most delicate means of detecting the presence of biliary colouring matters, when escaping by the urine in quantity too minute to be visible, or made visible by staining linen.

Nitric Acid.—Pour on a white plate, or sheet of writing-paper, a small quantity of the suspected urine, so as to form an exceedingly thin layer, and carefully allow a drop or two of nitric acid to fall upon it. An immediate play of colours, green and pink predominating, will, if the colouring matter of bile be present, appear around the spot where the acid falls.

Heller's Test.—Add to the urine any albuminous fluid,—serum of blood or white of egg; then pour in sufficient nitric acid to produce a considerable albuminous coagulum. Examined after a short repose, it will present a bluish or green colour if bile pigment existed in the urine; whilst, if none were present, the deposited mass will be white or merely slightly yellow.

But albumen precipitated by nitric acid in urine, destitute of bile, is more or less coloured, bluish or reddish; this appearance arising from the action of nitric acid on the colouring matter of the urine—uroxanthine. Dr Basham has observed this urinary coloured albumen most frequently in acute renal dropsy, and it is a very unfavourable sign.

Acetate of lead precipitates albumen, if present, in bilious urine, of a yellowish colour.

Colour of Phosphates.—After exposure of urine for a day or two, crystals of triple phosphate are deposited, having a yellow tinge. A very delicate and pretty test of bile colouring matter. (Hassall.)

For Bile Acids.—(a) *Pettenkofer's Test*: To a small quantity of the suspected urine in a test-tube, two-thirds of its volume of sulphuric acid are to be carefully added, taking care that the mixture, which soon becomes hot, never exceeds a temperature of 144 degrees. Three or four drops of a solution of one part of sugar to four of water are then added, and the mixture shaken. A violet-red colour is developed if bile be present. This familiar test was not much credited by Golding Bird. His experience led him to doubt its accuracy, and in applying it there are numerous sources of fallacy to be guarded against; chiefly, that the action of sulphuric acid on sugar develops a red colour in the absence of bile. A mixture of albumen or oil with sugar will, even in very minute quantities, under the action of sulphuric acid, produce a purple or scarlet colour, as Raspail long ago observed.

(b) *Hoppe's Test*—for a trace of bile acid. Treat the

suspected urine with excess of milk of lime, and boil for half an hour. Filter, and evaporate the clear fluid nearly to dryness, and then decompose with excess of strong hydrochloric acid. Boil the mixture for half an hour, renewing the acid from time to time, so as to prevent the spurting which would occur from over-concentration. Let the mixture completely cool, and then dilute with from six to eight times its volume of water. Filter the turbid solution, and wash the resinous mass, until the water runs through quite colourless. Dissolve the residue in spirit, containing 90 per cent. of real alcohol, decolorise with animal charcoal, again filter, and evaporate to dryness over a water-bath. The yellowish resinous residue is pure *cholidic* acid. On warming it, a peculiar musk-like odour is emitted. Dissolve this resinous matter in a little caustic soda and warm water, add a little sugar, and let fall, slowly, three drops of concentrated sulphuric acid into the mixture. The resinous acid is, at first, precipitated; but afterwards, the flakes adhering to the glass are slowly dissolved by adding more sulphuric acid, and there appears an entirely clear fluid, of a beautiful *dark violet* colour (Virchow's Archiv, vol. xiii; Archives of Med., vol. i). This test results from an elaborate process, but it is a very delicate and infallible one.

The following useful tables are from Dr. Golding Bird's work;* they contain reference to some deposits not hitherto described in this work, but which are here incidentally introduced :—

* 'Urinary Deposits,' &c. Edited by Dr. Birkett.

(1) *Table for the Microscopical Examination of Urinary Deposits.*

Deposit	amorphous,	and disappears on the addition of	
		liquor potassæ	Urates.
„	„	and permanent on the addition of	
		liquor potassæ . .	Phosphate of lime.
„	visibly crystalline,	and the crystals octohedral.*	
		Oxalate of lime.	
„	„	and the crystals hexagonal tables ;	
		soluble in ammonia . .	Cystine.
„	„	and the crystals, prismatic, or pen-	
		niform ; not soluble in ammonia,	
		but in acetic acid . . .	Neutral triple phosphate.
„	„	and the crystals radiated or folia-	
		ceous ; not soluble in ammonia,	
		but in acetic acid, with efferves-	
		cence . . .	Carbonate of lime.
„	„	and the crystals radiated or folia-	
		ceous ; not soluble in ammonia,	
		but in acetic acid, without effer-	
		vescence	Bibasic triple phosphate.†
„	„	and the crystals dumb-bells ; not	
		soluble in ammonia, but in acetic	
		acid, with effervescence. Car-	
		bonate of lime.	

* Arsenious acid, chloride of sodium, and the protoxide of antimony, assume the octohedral form, but are rarely present.

† Is not yet proved to exist in urine. (Thudichum.)

Deposit visibly crystalline, and the crystals dumb-bells ;		soluble by heat, but not in ammonia, nor acetic acid. Lithate of soda.
„	„	and the crystals dumb-bells ; insoluble [by heat, ammonia, and acetic acid. Oxalurate of lime.*
„	„	and the crystals dumb-bells, with fringed edges ; insoluble in alcohol and acetic acid, but soluble in liquor potassæ . Lithic acid.
„	„	and the crystals lozenge-shaped or compound ; insoluble in acetic acid and ammonia . Lithic acid.
„	„	and the crystals spherical, with or without spicules ; soluble by heat Lithate of soda.

(2) *Table for Discovering the Nature of Urinary Deposits by Chemical Reagents.*

Deposit white, and soluble by heat		Lithates.
„	„	and insoluble by heat, but soluble in ammonia Cystine.
„	„	and insoluble by heat and ammonia, but soluble in acetic acid . . Earthy phosphates.

* Is not yet proved to exist in urine. (Thudichum.)

The sediment may be *organized*; consisting of mucus, pus, epithelial cells from the genito-urinary passages, semen, blood, casts of uriniferous tubes, various other cells, and *débris* of tissue; or stringy, coagulable by acetic acid, and consisting of a tenacious matrix with cells, some small and round, others large and flat, with oval nuclei,—it is mucus; or consisting of spherical globules, not imbedded in a matrix, about $\frac{1}{16}$ th of an inch in diameter, studded with molecules and granules, and containing a double or triple nucleus on the addition of acetic acid,—it is pus.

- Deposit white, and insoluble by heat, ammonia, and acetic acid . . Oxalate or oxalurate of lime.
- „ coloured, and visibly crystalline . . Lithic acid.
- „ „ and amorphous, but pale, and readily soluble by heat Lithates.
- „ „ deeply, amorphous, and slowly soluble by heat. Lithates stained by purpurine.

GENERAL TREATMENT

The rational remedial treatment of any morbid condition is, essentially, the removal of the cause or causes in operation : its preventive treatment, their anticipation.

Having, therefore, fully considered the removal of the local diseases which induce irritability of the bladder, it became necessary, in order to complete its curative treatment, to trace the pathology of the *constitutional* diseases which generally are in operation, with their accompanying morbid conditions of urine, as the immediate causes ; describing the physical and microscopical characters, and the chemical tests, of these causative conditions, and estimating their diagnostic value as constitutional symptoms.

All this will lead to the removal of the causes referred to ; and their remedial treatment will be further enlightened by investigating the *social* origin of constitutional causes,—an aspect of etiology, which is, however, more especially suggestive with reference to preventive treatment.

Lithic Acid, and Lithates—Treatment.—The pathological origin of lithic acid in excess is mal-assimilation, primary or secondary; or it denotes an excess of animal food over and above the wants of the system, which is accordingly expelled *in limine* from the blood through the kidneys, without having contributed to the nourishment of the body. Hygienic measures, therefore, are most important. A reduced proportion of animal food is obviously the leading curative measure, and active exercise daily to increase the elimination of any excess is equally necessary.

No remedial measures are at present known for *directly* correcting mal-assimilation in respect to lithic acid or other products. The effect of increased bodily exercise may be to increase the destructive metamorphosis of the highly nitrogenous textures, *i.e.*, muscle, and thus directly increase the production of lithic acid; but this may also react beneficially in subsequently correcting the mal-assimilation.

Lithic acid passing off in the urine as lithate of ammonia is liable to be decomposed by the action of any free acid present in the urine; and lithic acid itself being insoluble appears as a deposit of reddish-yellow sand, consisting of crystals, which may aggregate and form a calculus. Hence the administration of *alkalies* to *neutralize* the acidity of the urine is indicated, of which bicarbonate of potash is, perhaps, the best for oft-repeated use. Other alkalies employed for this purpose are the bicarbonate of soda, as "Vichy water," the acetates, tartrates, and citrates of soda and potash, phosphates of soda and ammonia, and borates

of soda and potash. Conversely, the *removal* of any source of *acidity* is also indicated; but this refers again to hygienic considerations. With regard to food, the vegetable acids, or that which will form them, as sugar or starch in the food, should, in Dr Bence Jones's opinion, be prohibited. On the other hand, free perspiration to eliminate the acids of the sweat, the retention of which would precipitate uric acid in the urino, is scarcely less important. Warm clothing, warm bathing, friction with horsehair gloves and belt—an excellent skin stimulant—and diaphoretics, may thus prove most efficacious.

Lithate of ammonia being soluble in urine at the temperature of the body, its solution is secured, provided only that fluid be not overcharged. But dilution of the urine will best prevent supersaturation and deposit. The free use of aqueous drinks or soda water, is calculated to fulfil this indication, and thus probably prevent the formation of a lithate of ammonia calculus. Diuretics, which increase the secretion, will also aid the dilution of urine, and, moreover, tend to eliminate lithic acid or lithates from the system. The wine of colchicum, in doses of ten minims and upwards three times a day, prescribed with the carbonate of potash to keep the lithic acid in combination, the resulting lithates themselves being further held in solution by the administration of diluents, may together carry off both, and soothe the irritability of the bladder which accompanies their discharge. Saline aperients seem to contribute to this desirable result. Any prolonged subjection to such a course of elimination, requires also

the simultaneous action of small doses of blue pill, apparently to maintain the proportionate secretion of bile, which otherwise being virtually retained as compared with the secretion of urine, would disturb the balance of their constituents in the blood.

Preventive Treatment recognises the same rules with regard to food and exercise; alkalis also occasionally to intercept the deposit of lithic acid; and dilution to secure the solution of lithates.

Urea, excess in Urine—Treatment.—It should be remembered that urea—like uric acid, from which it may be derived—is produced, physiologically in the system, by the destructive metamorphosis of the highly nitrogenous textures, *i. e.*, muscle. Nitrogenous food is also, perhaps, a direct source of urea, and is assuredly followed by a rapid and very considerably increased production of this constituent of the urine. Its pathological origin is apparently similar; an excess being produced in connection with febrile conditions, and a deficiency in those of an opposite character. Consequently, the indications of curative treatment would appear to be; to lessen the daily toil and harass, which are well known to be associated with ureal diabetes, and, still guided by pathology, to reduce the supply of animal food. But this latter indication is not confirmed by experience. It is found necessary to repair the system by a generous diet, aided by tonics and alcoholic stimulants; the latter seeming to supply a material which readily oxidates, and thus protects the muscular tissue from premature decay, with that excessive production of urea which rapidly runs off through

the kidneys and incessantly irritates the bladder. The quantity of urine, and thence the frequency and urgency of micturition, may be reduced by opium, which tends also to soothe the general nervous excitement that accompanies exhaustion of mind and body.

Preventive Treatment is necessarily guided by similar considerations, only with an anticipatory application.

Phosphoric Acid, and Phosphates—Treatment.—Guided by its pathological origin, an excess of phosphoric acid, in combination with alkaline or earthy bases, suggests, primarily, the endeavour to arrest, if possible, that destructive metamorphosis of nervous tissue which generates phosphoric acid in abnormal quantity. Consequently, temporary freedom, at least from all anxiety and corroding care—in short, mental relaxation—is primarily imperative. But the phosphatic diathesis is encouraged by vegetable food. A more animal diet, therefore, with beer and wine, is scarcely less imperative.

Deposition of the Phosphates—phosphatic urine, implying, as it does, an alkaline state of this fluid, suggests the use of mineral acids. The nitric and nitromuriatic acids diluted are perhaps the most useful; although it must be confessed that the influence of any mineral acids on alkalinity of the urine is but slight. They are generally combined with vegetable tonics, as cinchona, and with apparent advantage. Opium also will aid in restoring acidity to the urine, besides subduing nervous excitement. Benzoic acid has been highly recommended, it being converted into hippuric acid during

its passage through the system. The earthy phosphates, *i. e.*, of lime and magnesia, may thus be held in solution and become invisible; the alkaline phosphates, *i. e.*, of soda and potash, never appearing. But the deposition of the former is effected by an excess of *fixed alkali*,—soda or potash in the urine. Another occasion of phosphatic urine, is an inflammatory state of the urinary mucous membrane, with the secretion of mucus, which acting apparently as a ferment, induces the decomposition of urea and liberation of carbonate of ammonia—a *volatile alkali*. The urine then becoming alkaline, deposits the triple phosphate of ammonia and magnesia with phosphate of lime. Alkalies, however, have been recommended by Dr Owen Rees, with the view of reducing the acidity of the urine as secreted; thus preventing its irritating the mucous membrane of the bladder, less mucus is secreted, and the urine in the bladder actually becomes more acid.

Preventive Treatment is determined by precisely the same considerations respecting the generation of phosphoric acid in excess, and thence the formation of phosphates in excess; and also respecting the deposition of (earthy) phosphates in the urine, whether by fixed or volatile alkali.

Oxalic Acid, and Oxalates—Treatment.—Considering the certain pathological origin of oxalic acid, in excess,—by the primary mal-assimilation of sugar and sugar-forming food, such food is contra-indicated. Every species of vegetable food is questionable; and those which contain oxalic acid, *e. g.*, rhubarb, sorrel, onions, and tomato, or certain medicines, *e. g.*, alkaline salts

with a vegetable acid, are unquestionably forbidden. Considering also the probable production of this acid, in excess, by the destructive metamorphoses of the nitrogenous tissues in secondary mal-assimilation, and its association with, or derivation from, lithic acid, a nitrogenous diet would seem to be contra-indicated. Nevertheless, experience shows that animal food, with brandy-and-water instead of beer or wine, form a suitable diet ; but the water should be distilled, to deprive it of lime, with which the oxalic acid otherwise combining would lead to the formation of a urinary calculus.

Appropriate medicinal treatment will aid regimen. The mineral acids are efficacious, particularly hydrochloric and nitro-muriatic acids, in conjunction with bitters. They were recommended by Dr Prout to be taken daily for about a month, or until lithic acid, or lithates, reappeared in the urine. By adopting, said he, such a course of acids three or four times in the year, and by a carefully regulated diet, I have seen this diathesis gradually subdued, and at length removed altogether. Irritability of the bladder, in connection therewith, is not unfrequently subdued by the compound tincture of camphor; indeed, Dr Bence Jones speaks of this remedy as having thus proved "very useful."

The association of oxalate of lime with uric acid in the urine, requires the anomalous administration of both acids and alkalies. In such cases, supposing the deposit of oxalate to be considerable and persistent, Dr Hassall suggests that it should be treated in the first instance.

If the uric acid deposit be constant and in large quantity, alkalies and acids may sometimes be administered with advantage alternately.

Preventive Treatment will consist in the avoidance of those articles of food which are apt to produce or actually contain oxalic acid, and in the observance of the suitable diet. Conjointly, the precautionary use of the appropriate medicinal measures, occasionally.

Sulphuric Acid—Treatment.—Animal and vegetable food having, apparently, equal influence in producing an excess of sulphates in the urine, no distinction can be drawn favorable to either kind of diet, as a remedial agent. But as sulphur is disengaged by the destructive metamorphosis of the nitrogenous tissues chiefly, and subsequently, by oxidation, is converted into sulphuric acid, active exercise, which increases both these changes, is contra-indicated. Repose, and the requisite remedial measures for subduing febrile excitement, are, perhaps, the general indications to be fulfilled. Eliminative treatment would, of course, be curative, by removing the excess of sulphuric acid from the system; but the present state of knowledge in this respect is here, as with regard to other blood-conditions, too unsettled for practical purposes.

Preventive Treatment consists in the anticipation and avoidance of the causative conditions above alluded to.

Hippuric Acid—Treatment.—This highly carbonaceous acid is produced in excess, either by vegetable food, itself too rich in carbon, or by medicine containing benzoic acid; perhaps also by the destructive meta-

morphosis of nitrogenous tissue, in secondary mal-assimilation; or by defective elimination of carbon through the liver, lungs, or skin. But little is known respecting remedial measures. The substitution of nitrogenous food, increased exercise, and the administration of medicines to increase the secretion of bile and sweat, would seem to be the most hopeful.

Preventive Treatment should be guided by similar considerations.

Lactic Acid—Treatment.—The pathological origin of this acid, in excess, is obscure. Food abounding with lactic acid, introduced by primary assimilation, is undoubtedly one source. Of such kinds of food, are, milk and vegetables which have become sour, and sugar or amylaceous food which may be converted into lactic acid. But an excess would also seem to arise, in some cases, from the destructive metamorphosis of muscular tissue, in secondary mal-assimilation; that tissue everywhere abounding with lactic acid. Mal-excretion through the skin is another alleged cause; the sweat, it is said, containing lactic acid. Hence the imputed pathological origin of rheumatism. Defective respiration is also an apparent cause; lactic acid by oxidation being readily converted into carbonic acid.

Taking these facts and opinions into consideration, the indications of treatment are; to correct any error of diet, to moderate bodily exertion, to maintain or increase the functions of the skin by warm clothing; and to render the respiration more active, by daily exercise, when the excess of lactic acid arises apparently from an opposite condition, in this respect.

Preventive Treatment, as usual, consists in the anticipatory observance of the curative indications.

Chlorides—Treatment.—Introduced into the system by most articles of food in the course of primary assimilation, and disengaged from the tissues by destructive metamorphosis in secondary assimilation, an excess of chlorides in the blood and urine proceeds either from the food, or increased transformation of the textures. Vegetable food in general contains a much larger relative amount of the chlorides of sodium and potassium, than animal food; and the component proportion of these salts in the various tissues of the body, is also different, and variable. Exercise of body and mind, as affecting chiefly the muscular and nervous systems, increases the chlorides in the urine. The remedial indications are obvious; an increased proportion of animal food, and rest.

Preventive Treatment is analogous, but anticipatory.

Sugar in Urine—Treatment.—This abnormal constituent of the urine may proceed, perhaps, from various sources; mal-assimilation—primary or secondary; but chiefly, from imperfect oxidation and destruction of the sugar-glucose produced in the liver, itself transformed glucogen, also produced in that organ. This, which is Bernard's theory, as founded on experimental observations, is disputed by Dr Pavy, whose observations led him to regard the transformation of glucogen ("hepatine") principally as a *post-mortem* change; but this again is denied by Dr Harley, whose investigations may, therefore, be regarded as indirectly supporting the views of Bernard.

The imperfect oxidation of sugar is not apparently connected with deficient respiration.

Besides this pathological origin of diabetes mellitus, there is also the accidental origin from injury to the medulla oblongata, and floor of the fourth ventricle, and to the sympathetic system of nerves.

Bearing in mind the pathological origin of this disease, the indications of treatment relate to diet rather than medicine. No known medicinal measures have hitherto proved essentially efficacious; but the disease can be controlled, and for an unlimited period, by an appropriate diet.

The rule to be observed is,—a scrupulous avoidance of every kind of food containing sugar, or which can be converted into sugar. Rigorous abstinence is not equally imperative in every case, yet the indication is the same.

Animal food, therefore—including fish of all kinds, and eggs—is quite unobjectionable; while of vegetable food, the choice is restricted to greens, bran-bread or cake, and such articles as do not belong to the saccharine class of aliments. Of liquids; brandy-and-water, tea and coffee, are safe.

The diabetic bill of fare does not allow of much variety, and constant self-denial is required to keep within its bounds. Nevertheless, certain indulgences may be granted with impunity; and, so far as the personal experience of *one* diabetic patient in particular affords adequate information for the guidance of others, Mr Camplin's observations* respecting himself are valuable and encouraging.

* 'Med.-Chir. Trans.,' vol. xxxviii.

Genoa macaroni proved to be one of the best substitutes for the bran-cake. Milk need not be forbidden. Cruciferous vegetables afford many agreeable varieties; cabbage, cauliflowers, broccoli, Brussels sprouts, &c.; sea-kale and spinach are quite harmless; onions may be permitted, and in most cases turnips. Lettuces agreed when eaten sparingly with oil and vinegar. Tea is preferable to coffee, and with it milk may be taken freely, cream only in small quantity. Cocoa is allowable if prepared from the "nibs," not that which is sold in cakes or powder. Pale French brandy should be taken, but only in measured quantities, say a table-spoonful with water. Wines are better excluded, excepting claret, which is a most suitable beverage.

Other hygienic means were very advantageous. Sponging with tepid water, followed by friction, proved highly salutary; so also sponging with cold salt water in summer, and an occasional warm bath in the winter. Warm clothing, a leather waistcoat, and gutta-percha soles to the boots in winter, appear equally important. Change of air and occupation were so favorable, that wheaten bread was substituted for the bran-cake during the period of relaxation.

A few words respecting medicinal treatment will suffice. Free perspiration affords some relief to the diuresis. Besides, therefore, the sudorific appliances just alluded to, the salts of ammonia are serviceable; the sesquicarbonate being an exception, at least it was so in Mr Camplin's case. Citrate of ammonia, combined with citrate of iron, was useful. Bitters and alkalies were very beneficial. Opiates are valuable in some

cases as a temporary means of checking the secretion of urine, and allaying irritability of the bladder.

Preventive Treatment.—Such also are the preventive measures—dietetic chiefly, hygienic and medicinal subserviently—by the early and patient employment of which diabetes may be kept in subjection, and for an unlimited period. It was thus that Mr Camplin not only rescued himself from a deplorable state of health, but was preserved from the ever-threatening recurrence of this disease during a period of no less than fourteen years.

Cod-liver oil in large quantities, seven or eight ounces daily, is highly recommended by Dr Bence Jones, in cases of considerable emaciation.*

Albumen in Urine—Treatment of Bright's disease.—The retention of urea and water, in the blood, with the discharge of albumen in the urine; and subsequently the proportionate exchange of water for albumen in this secretion, while the retention of urea in the blood progressively increases: these are the changes in the relation of the blood and urine, which are essentially of therapeutic importance. Nutriment in its best form,—albumen,—is incessantly draining away from the blood; while effete and noxious matter,—urea,—representing the decay of the textures, is constantly retained; thus conceding the powers of life to the dominion of death. Besides the symptoms incident to this double process of destruction by starvation and blood poisoning,—both of which are faithfully represented by the condition of the urine,—general

* ‘Stomach and Renal Diseases.’ Case p. 122.

dropsy supervenes, owing to the retention of the water, which infiltrating the cellular texture throughout the body, presents this additional symptom.

Structural and permanent changes in the kidney are the immediate causes in operation;—congestion, followed by pale interstitial effusion, with desquamation and damage of the tubuli uriniferi; fatty, or waxy (amyloid) degeneration of the effused matter; or its absorption and contraction, constituting the so-called granular degeneration of the kidney, which becomes small and withered; with, in either way, irreparable destruction of the organ.

Remembering this abstract of the pathology of Bright's disease, the primary indications of treatment are; to reverse, if possible, the relative conditions of the blood and urine, and thus restore the condition of health.

Cupping or blisters on the loins tends to remove the renal congestion; but beyond thus aiming at the root of the disease, the perilous state of the kidneys forbids any direct attempt to restore their function. Subsequently, diuretics may be tolerated, and then prove serviceable. Digitalis, squills, or the tincture of cantharides, cautiously administered, are, perhaps, the most efficacious. The pill originally prescribed by the late Dr Baillie is an admirable formula. It consists of powdered digitalis, half a grain, and squills, one grain, combined with three grains of blue pill; to be taken two or three times a day.

Palliative treatment will have for its object the discharge of water, which has accumulated in the system,

by other channels than the kidneys ; *i.e.*, through the bowels and skin. Hence, hydragogue cathartics, *e.g.*, elaterium, croton oil, gamboge, jalap with cream of tartar ; and diaphoretics, *e.g.*, citrate of ammonia, the compound powdered ipecacuanha (Dover's powder), and hot-air or sweating baths ; are singly, conjointly, or in succession, often remarkably useful and comforting.

Irritability of the bladder ceases as the natural constitution of the urinary secretion is restored ; but the last-named medicine—Dover's powder—will also be conducive to this result, besides having a special action on the skin.

A generous diet, consisting of an increased proportion of albuminous food, as in the form of eggs, is especially necessary in the chronic disease, to replace the albumen which has been lost, and is still passing away ; with tonics also to support the circulation. The preparations of bark are thus effectual, but those of iron more so, for in no disease, perhaps, are the red corpuscles of the blood so reduced.

Further details respecting remedial treatment belong rather to special works on this disease.

Preventive Treatment has reference rather to the *causes* of that primary alteration of renal structure, whence the pathology of the blood and urine proceed. Those causes are preventible, in most instances. Scarlatina is an occasional cause ; rarely, however, a productive one, unless brought into operation by cold. After scarlatina has run its course, the residue of poison remaining in the blood appears to be naturally

expelled by the kidneys, thus imposing extra functional duty on these organs; yet they generally fulfil their appointed task, unless when in this state of congestion, bordering on inflammatory excitement, exposure of the body to *cold* should further impose an additional and intolerable burden. Then, under the pressure of *extreme* congestion, albumen is filtered off, urea retained, and fibrile dropsy supervenes. This *additional* strain on the excretory power of the kidneys, and its results, are obviously preventible. So also the more prevalent intemperate use of spirituous liquors, entails extra work on the kidneys; but even this strain may be borne for years with impunity, although a hazardous experiment. Exposure to cold, however, becomes intolerable; it provokes albuminuria.

Such is the usual etiology of this disease, as originally investigated by Bright,* and which the experience of other observers has since confirmed. That "intemperance seems its most usual source, and exposure to cold the most common cause of its development."†

Bile in Urine—Treatment of Jaundice.—The retention of bile in the blood, and thence its effect on the system at large,—of which the escape of biliary colouring matter in the urine is symptomatic—is the pathological condition of therapeutic importance. But this again has reference to the structural conditions of the liver or adjacent organs, by which such

* * "Reports of Medical Cases selected with a view of illustrating the Symptoms and Cure of Diseases by a Reference to Morbid Anatomy," 1827, vol. i, p. 3.

† 'Guy's Hosp. Rep.,' 1836. Vol. I. Cases and Obs. illustrative of Renal Disease, accompanied with the secretion of Albuminous Urine, p. 339.

retention is effected. These causative conditions are;—either mechanical, by obstruction in the ducts, or externally, to the free flow of bile into the duodenum, thus permitting the absorption of the bile imprisoned; or, some structural disease of the liver,—arrest of secretion being then the immediate cause in operation, thus precluding the elimination of biliary constituents from the blood. Without any structural disease of the liver itself, arrest of its secretion may also be caused by various morbid states of the blood or of the nervous system, which, severally, paralysing the function of this organ, induce jaundice.

The indications of treatment which may be gathered from the pathology of jaundice are of different practical significance, and hopefulness. If the retention of bile be due to some mechanical obstruction only, that causative condition may cease, spontaneously. An impacted gall-stone will most probably pass, in the course of time; or the pressure externally, of any adjacent organ enlarged by disease, may itself be relieved, from time to time. Repeated opiates, or the warm bath, will also tend to soothe and relax spasm, in the one case; and an accidental turn in the course of the disease, may bring relief in the other. But with structural disease of the liver itself, remedial measures become necessary, yet the result is less hopeful. An appeal to the secretory power of the liver may have a satisfactory response; and thus the administration of the cholagogue purgatives, large doses of blue pill or taraxacum, with salines to unload the portal circulation, may be advisable. Arrest of secretion by the

influence of various blood-poisons, or powerful mental emotions, or the shock of bodily injury, affecting the nervous system, are cases scarcely within the reach of medicine. Thus, jaundice arising, occasionally, from pyæmic infection of the blood, from poisoned wounds, and from various fevers, subsides only as the morbid matters in operation are eliminated through other channels of excretion.

Preventive Treatment.—The appropriate preventive measures with regard to each of the *blood-diseases*, the causes and treatment of which we have now considered, are at once suggested by reference to the causes themselves.

Temperature is the main question to be considered in reference to the prevention of *jaundice*. Not that other etiological conditions are unimportant, but they are for the most part beyond our control.

A hot climate *predisposes* to jaundice by enfeebling the circulation and inducing congestion of the liver. It is probable also that diminished oxygenation of the blood, through habitually breathing a hot atmosphere, aids this effect on Europeans, prior to their acclimatization. Hydro-carbonaceous matter, ordinarily eliminated by the lungs, accumulates in the blood, and the liver becomes overtaxed; a burden increased by indulging in stimulating liquors, especially malt beverages, which, abounding with hydrocarbonaceous matter, fall heavily on this organ, and further tax its functional power beyond endurance.

Such being the predisposing influences of high temperature, any change of temperature approaching to

cold is the *immediate* or exciting cause of jaundice. In *every* case, Sir Ranald Martin affirms,* that he has seen in England amongst those who have returned from India, cold has been the immediate cause of this disease. Taking seventy-two cases of icterus typhoides, by Lebert, one third occurred in November and December.

The preventive measures suggested by these observations are plain. They are most important to persons about to visit any tropical climate. Although unavoidably subjected to the physiological influences of heat, certain precautions are available. Prudent moderation in the use of stimulating beverages, and the careful regulation of clothing, should be rigidly observed. Besides adequate protection against the vicissitudes of external temperature, the cautious indulgence of cold drinks or iced beverages, is an injunction not to be forgotten. On returning home, after residing for some time in a tropical climate, it is advisable, if possible, to pass the ensuing winter in a more even climate than that of England. And when residing again in this country, the continued observance of these precautions, especially as regards vicissitudes of temperature, will prove the most efficacious preventive measures.

URINARY CALCULI

Urinary calculus, or stone, signifies a concretion of one or more of the constituents of the urine, forming a hard mass.

* 'Influence of Tropical Climates in producing the Acute Endemic Diseases of Europeans,' ed. 2.

Origin.—Any such concretion originates from the precipitation of the component urinary constituents, as urinary deposits, in consequence of a loss of solvent capacity in the water of the urine. But this disturbance of solvent capacity may arise in either of three ways: (a) by an excess of any substance for the water to dissolve; (b) by a deficiency of water as the solvent; or (c), by the presence or absence of some third substance. Thus, then, different analyses of the urine occur in some part of the renal apparatus—kidneys or bladder—precipitating urinary deposits.

Production of Calculus.—The formation of a calculus may occur in either of two ways: (1) The deposit may aggregate from a focus of its own substance; (2) or around a foreign body, as a distinct *nucleus*, the more frequent mode; in either way forming a calculus.

In the former mode of production, aggregation depends on (a) an excess of insoluble constituents, and thence their *immediate* precipitation, *e.g.*, in the forms of uric acid, urate, and oxalate concretions; or (b), *stagnation* of urine in the bladder, in connection with paralysis, chronic cystitis, and hypertrophy of the organ, enlargement of the prostate, or stricture of the urethra, as causative conditions of retention of urine, *e.g.*, in the formation of phosphatic calculi.

The *nucleus*, when distinct, is some foreign body; a small clot of blood, or mucus, derived from the urinary organs in which the calculus originated; or it may be some extraneous foreign body, introduced into the

bladder through the urethra, or by wound or ulceration of the organ.

The *constituents* of a calculus are fixed, in the state of aggregation, by some kind of *cement*, apparently animal matter; as mucus, fibrin, or fatty matter; possibly blood, epithelium, or even pus.

The *seat* of origin, in the urinary organs, has already been adverted to; commonly, it is in the kidney or bladder; occasionally, however, in the urethra, as the dilatation behind a stricture; and thus a calculus is designated *renal* or *vesical*, possibly *urethral*. Generally, a urinary calculus originates in the kidney, and subsequently descends, as a small stone, into the bladder, where it increases by further concretion.

Urinary calculus differs in its physical characters and chemical composition; representing different classes and species of urinary calculi.

Chemical Composition.—Urinary calculi, in regard to their essential constituents, may be divided into two classes, a third class representing the more rare forms: (1) calculi consisting of uric acid and urate of ammonia, with their varieties, the oxalate of lime, uric or xanthic oxide, and cystic oxide or cystine; (2) phosphatic calculi in all their varieties, as phosphate of ammonia and magnesia or triple phosphate, phosphate of lime, and mixed phosphates of lime, magnesia, and ammonia, or the fusible calculus; (3) the fibrinous uro-stealith, carbonate of lime, and silicious calculi.

Physically considered, urinary calculus varies in point of size, shape, weight, colour, odour, consistence, appearance on section, and number. The *size* is ex-

tremely variable ; from that of a hemp-seed, pea, nut, or almond, to a cricket ball and occupying the whole cavity of the thickened bladder. Of such large-sized calculi, one may be seen in the Museum of the Royal College of Surgeons, and another in the valuable collection of the Norfolk and Norwich Hospital Museum. That in the College collection measures 16 inches around its long axis, and 14 inches around its short axis ; it weighs 44 ounces. An unsuccessful attempt was made by Mr Clive to remove it from Sir Walter Ogilvie, who died on the tenth day. A nearly similar sized stone was removed by Uytterhoeven of Brussels, by the high operation. Phosphatic calculi usually attain the largest size.

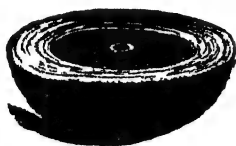
The *shape* also varies remarkably, and principally according to the situation and composition of the stone. Renal calculus is irregular, and often moulded to the form of the calices and pelvis of the kidney ; in the ureter, a stone is generally cylindrical ; the vesical is more uniformly of a flattened ovoid shape, or globular ; while the prostatic is pear-shaped, or singularly faceted. In relation to composition ; uric acid and urate of ammonia calculi are usually smooth and regular ; the oxalates tuberculated like a mulberry,—hence the common name of this calculus ; the phosphatic may be smooth and regular, or irregularly contorted. Many other forms are met with, which being readily recognised, need not be specified. The *weight* depends more on the composition than the size of the stone ; the phosphatic being very light, the oxalates very heavy, and uric acid or urates between the two. The average weight is an

ounce ; but extremes have been met with ; in a stone of 10 grs. taken from a boy ; another of nearly 6 ounces, removed by Sir A. Cooper, and another of 32 ounces, in the Museum of Trinity College, Cambridge. Of heavy calculi not removed, Deschamps saw one that weighed 51 ounces ; and Morand, one weighing 6 lbs—the heaviest on record. The *colour* of a calculus represents only the chemical nature of the surface or external crust of deposit ; the interior is often very different. A white surface signifies a phosphatic crust ; a cinder-grey, that of urate of ammonia ; a yellow pale brown, or brown, the uric acid ; cinnamon-brown, the uric or xanthic oxide ; a mahogany brown, brownish or blackish green, the oxalate of lime ; a grey-greenish or slate colour, the cystic oxide. The *odour* of a recently extracted calculus is sometimes peculiar. Phosphatic calculus may be ammoniacal, and oxalate of lime, on section, is said to emit a faint odour of semen. An aromatic smell, as of castor or musk, is sometimes perceptible. The *consistence* varies from that of mortar or sand to that of granite. But this will depend on the chemical nature of the calculus and on the intermixture of organic matter, or moisture in a recently extracted stone. Phosphatic calculus is generally soft ; the uric acid hard ; and the oxalates, very hard. The crust is usually softer than the interior, and the nucleus has the densest consistence. A rapidly formed stone is softer than one of slow production.

Section of a calculus presents a certain *structure* ; a distinct nucleus, in most species, and the surrounding concretion, which has an external crust, more or less

distinct. The concretion-substance is commonly disposed in concentric layers or laminæ (Fig. 52, and Fig. 53), and sometimes shows radiating lines from the centre to the circumference of the stone ; or it may be

FIG. 52.

*Bowman.*

Uric-acid Calculus.

FIG. 53.

*Bowman.*

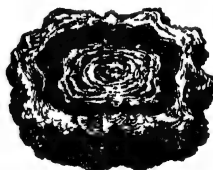
Urate-of-ammonia Calculus.

FIG. 54.

*(Bowman.)*

Phosphate-of-lime Calculus.

FIG. 55.

*(Bowman.)*

Oxalate-of-lime Calculus.

continuous, having no visible arrangement. The former appearance corresponds, apparently, to successively active periods of urinary deposit, as depending on varying states of the urine ; while the latter appearance would indicate the result of an uninterrupted deposit.

Simple calculus consists of only one chemical constituent, and thus presents a section uniform in colour and consistence (Fig. 54) ; *compound* calculus consists of different constituents, presenting a section of varying appearance at different depths (Fig. 54). Lami-

nation may occur in the formation of both a simple and a compound calculus. In the latter, the successive deposition of different matter may have a regular alternation, forming an *alternating* calculus (Fig. 56).

FIG. 56.



Bowman.

The *nucleus* varies, as already said, in its nature, and also in its situation, number, and connection with the surrounding concretion. Thus, commonly central, or nearly so, it may be very eccentric, as in some renal calculi; usually single, there may be two or several nuclei, as distinct centres of concentric deposition; and usually connected and fixed, the nucleus may be isolated and loose, owing apparently to a layer of blood or mucus having first gathered around it, followed by the concretion, while the organic matter has dried and disintegrated, isolating the nucleus. Lastly, the latter may itself have disappeared, leaving a central cavity; this result ensuing, probably, when the nucleus was organic matter which has undergone disintegration.

The *differential* Physical characters of the various species of calculi are indicated in Table (I).

(L.) TABLE INDICATING THE PHYSICAL CHARACTERS OF URINARY CALCULI.
Arranged in the Order of their Chemical Affinity with regard to Tests. (See TABLE II.)

	COLOUR.	SHAPE.	SIZE.	WEIGHT.	CONSISTENCE.	SECTION.
Uric or lithic acid.	Brown, light, or dark.	Ovoid and flattened.	Pea to orange.	Heavy.	Hard; fractured into sharp angular fragments and crystalline.	Concentric laminae, radiating lines from nucleus.
✓ Urate of ammonia.	Clay or slate, or reddish brown.	Ovoid, smooth, or tuberculated.	Small.	—	Fracture earthy (not crystalline).	Homogeneous.
✓ Uric or xanthic oxide; very rare.	Cinnamon.	Flattened.	Small, as pullet's egg.	—	Hard; fracture not crystalline.	Laminated.
✓ Cystic oxide or cystine, rare.	Yellowish brown; grey-green or slate after long exposure; and waxy, glistening, slightly transparent.	Round, smooth, or tuberculated.	Small.	—	Soft and pulverulent; fracture crystalline; powder is white.	Homogeneous, with imperfect radiation.
✓ Fibrous calculus; rare.	Yellow.	Pea-shaped	—	—	Fracture vitreous and lustrous; like yellow wax.	
✓ Urin-stearth; very rare.	Reinous or fatty bodies	—	Small.	—		
✓ Blood-calculus; very rare.	Dianteregrated blood-corpuscles, with phosphate of lime; black colour.	—	From corander-seed to horse-bean	—	Friable; fracture amorphous.	Amorphous; dark rusty.

Carbonate of lime; very rare.	White or ash.	Spherical or irregular.	Pea to nut, or larger.	—	Soft and friable; or very hard; fracture amorphous.	No concentric laminae, or imperfectly lamellar.
Oxalate of lime, or mulberry calculus.	Dark brown or blackish green.	Spheroidal, tuberculated, angular, or spinous; rarely smooth.	Marble to horse-chestnut	Very heavy	Very hard; fracture crystalline.	Imperfectly laminated in irregular waved lines.
Varieties; rare.						
✓ Hemp-seed calculus						
✓ Crystalline.	White-brown.					
✓ Ditto.	Pure white.					
✓ Phosphate of ammonia and magnesia.—Triple phosphate.	White or grey.	Irregular; somewhat spiculated.	Large probably.	—	Friable fracture, perhaps crystalline.	Imperfectly laminated.
✓ Phosphate of lime, renal origin.	Pale brown.	Spheroidal and smooth.	Small.	—	Friable.	Laminated.
✓ Vesical origin; bone-earth phosphate	—	Irregular masses, or granular semi-crystalline powder in tenacious mucus.				
Phosphate of magnesia and ammonia, with phosphate of lime—Mixed phosphates. Fusible calculus.	White grey or dull yellow.	Very irregular; mottled to locality; sometimes globular or ovoid, or in pieces, cubic or tetrahedral	Large probably.	—	Very friable or pulverescent, or soft, like moist chalk.	Concentric laminae, or semi-crystalline, or amorphous, according to proportion of phosphates.
✓ Silicious calculus, only in other calculi.						

The *number* of calculi varies chiefly according to the seat of the stone. In the bladder, usually there is only one; in the kidney, two or more; and in the prostate several. Vesical calculi are, however, sometimes numerous; two to six or eight are not very uncommon; and instances are on record of 117; 142 about the size of marbles, were removed by Sir A. Cooper; 307, 678, and even 1000 have been found; the latter number having been extracted by Dr Physick from an American Judge. This number is the largest on record; the stones varied in size from partridge shot to a bean.

The *relative frequency* of different calculi varies in different countries. Thus, comparing India and England:—(1). In Bombay, the proportion of oxalate of lime calculus is about twice that in England, taking standard collections of calculi, for comparison, in both countries. (2). The proportion of uric acid calculi is considerably less in India than in England; in the former country, urate-of-ammonia calculi are somewhat more frequent than uric-acid calculi, and conversely in England. (3). The proportion of phosphatic calculi is much less in India than in England, owing to the rarity of the mixed phosphates in the former country. In making these estimates, the calculi compared relate to the composition of the nucleus, or the entire substance of the concretions.

Examination of Urinary Calculi.—The *appliances* requisite for the examination of calculi are few and simple: a platinum spoon or piece of platinum foil, a spirit-lamp, and sometimes the aid of a blow-pipe; test-tubes, and watch-glasses with the acids—nitric and

hydrochloric, and the alkalies—carbonate of potash and oxalate of ammonia. Certain *special* reagents will be noticed in the Table.

The *order of procedure* is, first to test a bit of the calculus in powder, by *heat*, and thus refer it to one of the two divisions;—calculi combustible and destroyed by heat, leaving only a very little residue; or, calculi non-combustible, and not destroyed by heat, leaving a considerable residue. In the former case, the original powder is to be tested for uric acid, urate of ammonia, uric oxide, or cystic oxide; in the latter case, it is to be tested for (carbonate of lime) oxalate of lime, ammoniaco-magnesian, or triple, phosphate, phosphate of lime, or the mixed phosphates. Next, the *mineral acid* test is to be applied; if a combustible calculus, dilute nitric acid should be used; if a non-combustible calculus, dilute hydrochloric acid is preferable. Then, the *alkaline* test must be applied. Lastly, the *special tests* may be resorted to.

Calculi will be conveniently described in the order of their chemical affinity, with regard to *Tests*.

(1) *Uric, or Lithic acid Calculus*.—The most common of all calculi, is that consisting of lithic acid. It was discovered by Scheele in 1776. Its colour is generally light brown, varying however from pale brown to dark brown; and sometimes whitish on the surface, owing to its having become coated with amorphous urate of ammonia or with phosphate of lime. The shape is usually ovoid, and somewhat flattened; the surface smooth, or beset with small tubercles, so as to resemble the surface of oxalate of lime calculus; the size varies

from that of a pea to an orange ; and its consistence is hard in proportion to the purity of the calculus ; sometimes emitting a ringing sound on percussion, and breaking up into sharp angular fragments. The calculus is composed of concentric laminæ, and presents lines or fibres radiating from the centre to the circumference of the stone ; both these appearances are marked in proportion to the purity of the calculus, and determine the lines of fracture when the stone is broken. The nucleus may be quite white, although consisting of pure uric acid ; owing, as Dr G. O. Rees has shown, to the absence of colouring matter. The fracture is crystalline. *Tests* :—Combustible, and destroyed by heat ; turned red by nitric acid, forming a murexide ; soluble in carbonate of potash, evolving *no* ammonia.

(2) *Urate of Ammonia Calculus*.—This is not a common form of calculus, urate of ammonia being soluble in warm urine ; and it is generally confined to children. It was discovered by Fourcroy and Vauquelin in 1798. The colour of this calculus is that of clay or slate, and pretty characteristic, but less so when inclining to red or brown ; it has an ovoid shape, and a smooth or slightly tuberculated surface, and is of small size ; the section is homogeneous, seldom presenting a distinctly concentric laminated condition. Fracture is earthy,—not crystalline. *Tests* :—Combustible, and destroyed by heat ; turned red by nitric acid, forming a murexide ; soluble in carbonate of potash, evolving ammonia.

Urates of *Soda* or *Lime* are not found as calculi ; these urates are mixed with urate of ammonia or uric acid in compound calculi.

(3) *Uric or Xanthic Oxide Calculus*.—A very rare calculus, four specimens only have been recorded. It was discovered by Dr Marcet in 1715. The calculus has a cinnamon colour, a somewhat flattened shape and small size,—resembling a flattened pullet's egg, in a stone examined by Stromeyer; its texture is hard and laminated. Fracture, not crystalline. Uric oxide bears a close relation to uric acid, and results apparently from an imperfect oxidation of the chemical material which forms uric acid. *Test*:—Combustible, and destroyed by heat, but not turned red by nitric acid; soluble in ammonia, *not* crystallising when evaporated; insoluble in carbonate of potash.

(4) *Cystic Oxide, or Cystine Calculus*.—This also is a rare calculus, discovered by Wollaston in 1810. It has a yellowish-brown colour, approaching that of the uric-acid calculus, but after long exposure, it changes to a peculiar grey-greenish or slate colour; there is also a characteristic waxy, glistening, and slightly transparent appearance. Rounded and smooth or tuberculated, and of small size, the consistence is soft and pulverescent; a section exhibits no tendency to concentric laminæ, and only very imperfect radiation. The fracture is crystalline; powder scraped with a knife is perfectly white, whether the stone be brown or green. Hereditary disposition to the formation of this calculus is strongly evinced; 22 cases, 10 occurred in four families, and in 3 cases, the subjects were brothers. Cystic-oxide calculus differs from all others chemically, in containing a large proportion of sulphur,—about 26 per cent. It originates in the kidney, and not in the

bladder, as its name might imply. *Tests* :—Combustible, and destroyed by heat, but not turned red by nitric acid: soluble in ammonia, crystallising when evaporated in six-sided plates; soluble in strong caustic potash.

(5) *Fibrinous Calculus*.—Described by Dr Marcet and Dr Prout; this rare calculus so called, seems to have occurred in the form of pea-shaped bodies, of a yellow colour, and consisting of dried, coagulated albuminous matter. It can scarcely be regarded as a concretion, although such masses have presented considerable lustre and a vitreous fracture; resembling yellow wax in appearance. *Tests* :—It may be distinguished from cystine, by being soluble with difficulty, in ammonia, and not crystallising when evaporated.

(6) *Uro-Stealith Calculus*.—Another very rare pseudo-form of calculus, consisting of resin or fatty-matter. It was originally described by Heller in 1844; several small bodies of this kind having been passed by a man, aged twenty-four, who suffered from symptoms of stone. Since that time, Dr Moore of Dublin, has examined several specimens sent to him by Dr Robert Adams. *Tests* :—Soluble in ether and caustic potash; insoluble in boiling water and nearly so in alcohol; when heated and melted, the odour of benzoin is emitted.

(7) *Blood Calculus*, consists apparently of disintegrated blood-corpuscles associated with phosphate of lime; it therefore represents another form of pseudo-calculus, and which is also very rare. Described by Dr Alison, and examined by Dr G. O. Rees; a few

such calculi were found in the pelvis of the kidney of a man who died of consumption. They had a black colour, and ranged in size from a coriander-seed to a small horse-bean; they were friable, and the fractured surface presented an amorphous, dark rusty appearance. *Tests* seem to have elicited nothing peculiar; the calculus-matter was partly combustible, and soluble in liquor potassæ.

(8) *Carbonate of Lime Calculus*.—An extremely rare form of calculus, discovered by Brugnatelli in 1819. Of a perfectly white or an ash colour, spherical or irregular, and varying in size from a pea to a nut or larger; the consistence is usually soft and friable, but sometimes very hard. Section shows no concentric laminæ or only an imperfect lamellar structure. The texture is amorphous. Prostatic calculi consist almost entirely of carbonate of lime, as Dr Thudichum has shown; but it is always doubtful whether the lime or the carbonic acid were in any case derived from the urine. *Tests*:—Not combustible, and not destroyed by heat; soluble with hydrochloric acid, effervesces *before* heating; soluble in acid, when neutralised, gives a precipitate with carbonated alkalis and oxalate of ammonia.

(9) *Oxalate of Lime Calculus*.—This is the next most common after the uric acid calculus. It was discovered by Wollaston in 1797, but the nature of oxalic acid deposit was long afterwards originally investigated by Dr Golding Bird. The colour is rich mahogany brown, or sometimes blackish green; the shape spheroidal, and surface tuberculated, angular, or

even spinous, rarely perfectly smooth ; and varying in size from a marble to a horse-chestnut. This remarkable colour and external appearance, have given the special name "mulberry" to the oxalate of lime calculus. Its density and weight are great ; and section shows an imperfectly laminated structure of irregular waved lines, often resembling knotted heart of oak ; occasionally, a notably radiated appearance, like a series of minute needles placed side by side. The fracture is crystalline. Dr Lionel Beale has specially traced the formation of this calculus, from an oxalate-of-lime concretion not larger than 1-500th of an inch ; and he finds that dumb-bell crystals are first aggregated together into a small collection, in the interstices of which crystalline matter is deposited, forming a microscopic calculus.

Varieties of appearance are produced by the deposition of crystallised oxalate of lime on the surface of the calculus ; sometimes as a coating of transparent octohedrons, or it may be opaque ; and the calculus looks as if studded with pearl-spar. The deposition also of amorphous matter, as urates or phosphates may fill up the intervals between the tubercles or spines, and give the whole an ovoid shape. In compound calculi, oxalate of lime deposition presents the beautiful appearance of fortification *à*gate.

Rarer *varieties* are occasionally met with. The small, smooth, globular "hemp-seed" calculus, of a light brown colour. Also, the calculus, of a white or pale brown colour, and crystalline throughout. Lastly, the pure white oxalate of lime calculus. These varie-

ties are generally found in the kidney. *Tests* :—Not combustible, and not destroyed by heat; soluble with hydrochloric acid, effervesces *after* heating; solution in acid, when neutralised, gives a precipitate with carbonated alkalies and oxalate of ammonia.

(10) *Phosphate of Ammonia and Magnesia*—or *Triple Phosphate*—*Calculus*.—Discovered by Wollaston in 1797, this calculus is not common. It is of a white or grey colour, irregular shape and somewhat spiculated, may attain a large size, and has a friable consistence; is imperfectly laminated, and the fracture sometimes crystalline like alabaster. *Tests* :—Not combustible, and not destroyed by heat; soluble with hydrochloric acid, but does *not* effervesce either *before* or *after* heating; solution in acid, with excess of ammonia, gives a crystalline precipitate.

(11) *Phosphate of Lime Calculus*—also discovered by Wollaston in 1797, is rarely found in the bladder uncombined with other salts; and it seldom forms the nucleus of other calculi. It has a pale brown colour; spheroidal form and smooth surface; is usually small, friable, and laminated. This condition of the calculus is of *renal* origin, and consists of the neutral phosphate of lime. Another condition is of *vesical* origin, and consists of bone-earth phosphate; it occurs in the shape of irregular masses resembling mortar, or a granular semi-crystalline powder, enveloped in a tenacious mucus. Phosphates form around other calculi, or foreign bodies; but they are scarcely ever succeeded by a deposit of uric acid or urate of ammonia, or of oxalate of lime. *Tests* :—Not combustible, and not destroyed

by heat ; soluble with hydrochloric acid, but does *not* effervesce either *before* or *after* heating ; solution in acid, with excess of ammonia, gives an amorphous precipitate.

(12) *Phosphate of Lime, and Phosphate of Magnesia and Ammonia Calculus—or the Mixed Phosphates—Fusible Calculus.*—Another discovery by Wollaston in 1797, this is the most common of the three phosphatic calculi, and represents rather more than 1 in 12 of all calculi. The calculus is of a white, grey, or dull yellow colour ; generally of a very irregular shape, and moulds itself to the situation where found ; sometimes globular or ovoid, sometimes in many pieces and assuming a cubic or tetrahedral form. It may attain a considerable size, and has a very friable consistence and pulverescent character, or a soft consistence, resembling moist chalk. Section shows generally a concentric lamellar structure, and sometimes shining crystals of the triple phosphate between the laminae, or a semi-crystalline appearance. The relative proportion of the constituent phosphates varies exceedingly, and the predominance of one or the other phosphate gives peculiar characters ; an abundance of triple phosphate presents a crystalline texture, while that of phosphate of lime exhibits an amorphous earthy appearance. Mixed phosphates are more commonly deposited on foreign bodies introduced into the bladder ; encrusting them with white friable calculous masses. *Tests* :—Not combustible, and not destroyed by heat ; soluble with hydrochloric acid, but does *not* effervesce either *before* or *after* heating ; solution in acid, with excess of ammonia, gives a white, partly

crystalline, partly amorphous, precipitate ; without addition, easily *fusible* before the blow-pipe.

(13) *Silicious Calculus*.—As a separate concretion this calculus has not been met with ; but silica has been found in other calculi by Berzelius, Vauquelin, Fourcroy, and VENABLES. *Tests* :—Silica is negative with regard to all the tests for other concretions ; it is *not* acted on, by heat, acids, or alkalies.

The *relations* of Calculi to *Tests*,—general and special, are shown in the following Table (II), which represents also the *order* of chemical examination. It is enlarged from the well-known Lectures of Dr Bence Jones on Animal Chemistry :—

(II.) TABLE FOR EXAMINING URINARY CALCULI.

1. BY HEAT.	2. BY ACIDS.	3. BY ALKALIES.	NATURE OF THE CALCULI.	SPECIAL TESTS.
Destroyed by heat.	With nitric acid, red.	Soluble in carbonate of potash, evolving no ammonia. Soluble in carbonate of potash, evolving ammonia. Soluble in ammonia, not crystallizing when evaporated.	Uric acid. Urate of ammonia. Uric or xanthic oxide.	Solution in caustic ammonia or potash, on the addition of an excess of acid, crystallizes in angular crystals. Not soluble in water. Soluble in water, when boiled. Solution in water, with a few drops of ammonia, evaporated, crystallizes in needles—microscopic. Insoluble in carbonate of potash; dissolves without effervescing in nitric acid, leaving a lemon-coloured residue, soluble in strong sulphuric acid, not precipitated by dilution. Soluble in strong caustic potash; the solution, boiled for a few moments, on the addition of a drop of dilute acetate of lead, gives sulphuret of lead.
Not destroyed by heat.	With nitric acid, not red.	Soluble in ammonia with difficulty, not crystallizing Solution in acid, when neutralized, gives a precipitate with carbonated alkalies and oxalate of ammonia Solution in acid, when neutralized, gives a precipitate with carbonated alkalies and oxalate of ammonia Solution in acid, with excess of ammonia, gives a crystalline precipitate Solution in acid, with excess of ammonia, gives an amorphous precipitate. Solution in acid, with excess of ammonia, gives a white, partly crystalline, partly amorphous precipitate.	Fibrin. Carbonate of lime Oxalate of lime. Phosphate of ammonia and magnesia. Phosphate of lime. Mixed phosphates.	With nitric acid becomes directly yellow. Solution in caustic potash precipitable by acetic acid in amorphous form. Soluble in dilute acetic acid, with effervescence. Insoluble in acetic acid. Boiled with carbonate of soda, oxalate of soda is dissolved, precipitated by chloride of calcium. With half its bulk of phosphate of lime (bone-earth), is very fusible before the blow-pipe. With twice its bulk of phosphate of ammonia and magnesia, is very fusible before the blow-pipe. Without addition, easily fusible before the blow-pipe.
Not acted on	Not acted on.	Not acted on.	Silica.	Fused with twice its bulk of carbonate of soda, forms glass; soluble in water, precipitable by hydrochloric acid.

Causes of Urinary Calculi.—The urinary production or formation of calculus has already been noticed. *Predisposing* causes are here considered.

Climate and locality have apparently some predisposing influence. Calculus is more common in temperate than in warm and cold regions, and more especially in humid countries of moderate and changeable temperature, such as Holland, France, Germany, and England. It occurs, however, very frequently in Egypt, Isle of France, Russia, Bagdad, and both the East and West Indies. Some parts of the same country are certainly more prone to calculus production than other parts; as particularly the county of Norfolk in this country. *Race*, it is said, has different proclivities; that calculous disorders are more common among white than dark races of men, yet stone is of very frequent occurrence among the natives of India.

Hereditary transmission is evinced in the gouty diathesis, and the production of lithic acid calculi.

Sex undoubtedly affects the relative proportion; stone is less frequent in females than males, in the proportion of 1 to 20, or 1 to 23. This remarkable disproportion is attributed mainly to the peculiar anatomical disposition of the female urethra; its comparative shortness, larger size, dilatibility, and straight course, all these circumstances facilitating the passage of a small stone.

Period of Life or Age.—Stone may occur at any age; and, according to Stahl and Geyer, it occasionally exists as an intra-uterine affection. But the two extremes of life seem to be most subject; stone being met with

most frequently, it is said, in young and in old people. Of 5,376 cases collected by Civiale : 1,946 occurred before the age of 10 years, 943 from 10 to 20, 460 from 20 to 30, 330 from 30 to 40, 391 from 40 to 50, 513 from 50 to 60, 577 from 60 to 70, 199 from 70 to 80, and 17 after 80 years of age. Coulson has collected 3,264 cases of lithotomy : under 20 years of age, the proportion was 71·20 per cent. ; between 21 and 40 years, 12·10 per cent. ; between 41 and 60, 10·87 per cent. ; and between 61 and 80, 5·72 per cent. Sir H. Thompson's table comprises 1,827 cases : under 20 years of age, 60·42 per cent. ; between 21 and 40, 10·18 per cent. ; between 41 and 60, 17·56 per cent. ; and between 61 and 81, 11·83 per cent. Respecting the value of these statistics, Mr Coulson has well remarked, that they represent the absolute number of persons affected with stone at different ages ; but not as relative to the total number of persons living at the several periods of life. Thus, if all persons under 20 years were affected with a certain disease, and all persons over 70 years were affected with the same disease, the liability would be the same, although the absolute number of persons attacked would be very different. By correcting this error between absolute and relative numbers, the tables would show that children and young persons are less liable to calculous disorders than is commonly supposed ; that from 20 years upwards, the tendency goes on increasing in a very remarkable manner to the end of life. Sir H. Thompson thus expresses it : " That the proportion of elderly calculous patients to the existing population at their own ages is larger than

the proportion of children affected is to the number of existing children."

Habits of life have unquestionably some causative tendency. Thus, sedentary habits diminish the perspiratory secretion, and throw increased work on the kidneys; high living, and especially indulgence in various kinds of nitrogenized food, and certain beverages, supply the material for uric acid and other allied concretions, while indigestion and secondary mal-assimilation in the textures generate uric acid.

Various morbid conditions of the *urinary organs* may induce calculous formations; the presence of a foreign body especially, which solicits the precipitation and deposition of the urinary constituents around itself as a nucleus.

Other accredited causes are doubtful. Thus, the imputed influence of certain mineral waters is fallacious, none of the forms of calculi corresponding to the salts in such waters. The alleged exemption of persons in certain occupations, as soldiers and sailors, seems very doubtful.

Diagnosis of Urinary Calculi.—In relation to treatment—whether medical or surgical, and especially the former, the *species* of urinary calculus is a question of great importance.

The elements which, singly or collectively, determine the diagnosis are,—the examination of gravel or small portions of concretion passed in the urine, the accompanying condition of urine, the constitutional condition or diathesis, and the other predisposing causes already enumerated. If all this knowledge should

fail to establish any positive conclusion as to the nature of a calculus, it may at least have a *negative* value, by indicating the species to which the stone is not allied, and thus indirectly guide to an appropriate treatment.

The examination of *gravel* or small portions of concretion, supplies the most exact knowledge relative to the species of calculus coexisting.

The condition of *urine* passed at the same period, affords the next most reliable ground of diagnosis. Urinary reaction and deposits are here the indications to be observed.

The *reaction* may be acid or alkaline; and the latter from fixed alkali, or from volatile alkali,—carbonate of ammonia.

(1) *Acid* reaction will indicate that the calculus is either uric acid or oxalate of lime, or a combination of both species of concretion. A *deposit* of one or other of these constituents can alone determine the particular species of calculus. Not unfrequently, either deposit alternates with the other, and then a combination of both may be inferred. The presence of either deposit in the urine for any considerable period would indicate that the external crust of the stone is of that kind; but this will fail to indicate the composition of the deeper substance.

Renal calculi contrast with vesical calculi, in being much more simple, consisting usually of only one species; while the vesical are usually compound, consisting of two or more species. This complexity increases often according to the period during which

the calculus has remained in the bladder. Consequently, if the calculus originated in the kidney, but has descended into the bladder at a recent date, it will probably be *simple*; and while an acid reaction might indicate either uric acid or oxalate of lime, the deposit will probably determine which species constitutes, in this case, the *entire* calculus.

The relatively greater *frequency* of uric acid compared with oxalate of lime calculus, is a consideration which may aid and corroborate an otherwise doubtful diagnosis; but such evidence is of much less value than that derived from examination of the urine.

Constitutional predisposition supplies a more important element in our calculation of probability. Thus the gouty diathesis will more probably be associated with uric acid than with oxalate of lime calculus.

(2) *Alkaline* urine has a widely different significance, according to the nature of the alkali. *Fixed* alkali is associated with phosphate of lime, or with carbonate of lime. Both these species of calculi are rare, and the latter extremely so. *Volatile* alkali-carbonate of ammonia is always associated with a calculus—when present—the crust, at least, of which consists of phosphate of ammonia and magnesia, with phosphate of lime, forming the mixed phosphates or fusible calculus. Yet the composition of the nucleus and body of the calculus cannot be inferred. The thickness of the crust varies according to the greater or less degree of ammoniacal reaction and odour; and this, again, will be influenced by the quantity of mucopurulent secretion, as estimated by its discharge in the

urine; but the duration of this twofold condition of urine will, of course, affect the resulting proportion of the encrusting deposit. At length, however, portions of phosphatic concretion may be passed with the urine. It is necessary to observe that the urine is ammoniacal when passed, and not as the result of decomposition, subsequently.

TREATMENT OF CALCULI

Urinary calculi may be subjected to two kinds of treatment; medical and surgical.

Medical treatment has two objects in view; the *prevention* of the formation of a calculus, when the causative conditions predisposing thereto exist; the *removal* of a calculus, by solution, and the expulsion of its constituents through the urethra, or the solvent treatment.

Surgical treatment is restricted to the accomplishment of the latter object,—the removal of a calculus, and by means of certain operative or mechanical procedures; *lithotrity*, the removal of a stone mechanically, by crushing it in the bladder with instruments, and extraction or expulsion piecemeal of the *débris* through the urethra, or perhaps by simple dilatation of the urethra without any cutting operation; *lithotomy*, or the extraction of stone by a cutting operation.

The two kinds of treatment are here stated in the order of their relative desirability, but their practicability is nearly the reverse, surgical treatment being generally far more effectually curative. Still, however,

to complete this Treatise, I shall here notice the medical treatment of calculi, especially from a preventive point of view ; operative procedures having been already fully considered.

Preventive Treatment.—The prevention of calculous concretion implies the recognition of any such signs as may indicate a predisposition thereto, and in due time to anticipate this result. An habitual and persistent *deposit* in the urine of some one or more of the constituents of a calculus, affords the surest evidence of the probable issue. Thus, persistent deposits of uric acid, urates, oxalate of lime, earthy phosphates, or cystine, as the constituents, severally, of the more common species of urinary calculi, are premonitory of their formation ; but only under certain circumstances of urinary deposit. The significant conditions are, when the deposit, as of uric acid or oxalate of lime, is found in the urine, immediately after micturition, or is deposited before it has cooled. Either appearance would indicate that the constituent of one or the other concretion is secreted with the urine. Whereas, the same appearance taking place at a subsequent period, when the urine has stood for a few hours, might be the result of after-changes. An ammoniacal condition of urine, in connection with cystitis, has always a tendency to concretion of the earthy phosphates deposited. The liability to calculous formation cannot be doubted whenever any portion of concretion has passed with the urine, or the patient has undergone an operation, lithotrity or lithotomy, for the removal of stone from the bladder.

Preventive treatment may be general, as relating to all calculi ; or special, as relating to the different species of stone. The *general* indications are to prevent any concentration of urine, and its prolonged retention in the bladder. Either, or both conditions would obviously have a direct causative tendency to the formation of calculous concretion. Concentration of the urine occurs mostly after fasting, some hours previous to the next meal, and during sleep ; in the latter physiological state of the system also, the urine is not only scanty, but retained in the bladder for a longer period than in the day-time. And during fasting or sleep—states of the system more or less remote from the process of digestion—the urine becomes highly acid ; but again more nearly alkaline after a meal, when a flow of the acid gastric juice into the stomach, reduces the acidity of the blood. The recumbent posture, during sleep, was conceived by Dr Prout, to favour the accumulation of urine in the pelvis of the kidney, and thus possibly induce the formation of renal calculus.

To meet all these contingencies, an increased quantity of water or other aqueous fluid should be drank, especially after an interval since food was taken, or at bed-time. The intervals between meals, moreover, should not be protracted, nor sleep in bed unnecessarily prolonged. Thus, a tumbler of water may be taken once or twice daily ; particularly before a late dinner, and on going to bed ; while, instead, perhaps, of only two meals a-day, breakfast and dinner, luncheon should also be taken, at nearly equal intervals, and early rising should be enjoined. The latter precaution will

be of less consequence if the individual be accustomed to wake once or twice in the night, when the bladder can be relieved of its contents.

Special Preventive Measures.—Predisposition to the formation of *uric acid* calculus may be controlled by the medicinal and dietetic measures already noticed in relation to the precipitation of this acid as a urinary deposit. Alkalies, such as the bicarbonate, acetate, or citrate of potash, in drachm. doses to a tumbler of water, as a diluent, should be taken morning and evening. Vichy water or lithia water may be drank in preference. A reduced proportion of animal or azotised food and more active exercise to carry off any excess, will also have a preventive tendency. Free perspiration, to eliminate the acids of the sweat, the retention of which would precipitate uric acid in the urine, is scarcely less important. Hence, warm clothing, warm bathing, friction of the skin by the daily morning use of Turkish towels, or horse-hair gloves and belt, are most efficacious.

Predisposition to *oxalate of lime* concretion may probably be kept in subjection by the observance of similar precautions. Aqueous drinks to prevent any supersaturated solution of the oxalate; and the avoidance of those articles of diet which contain, or perhaps generate, oxalic acid, as rhubarb, sorrel, onions, tomato, and sugar, or sugar-forming food. Animal food, with brandy and water instead of beer or wine, form a suitable diet; but no hard water should be drank, it should be distilled, to deprive it of lime. Otherwise, the lime combining with oxalic acid would

induce the urinary concretion. Medicinal preventive measures may be either acids or alkalies. The mineral acids, particularly hydrochloric and nitro-muriatic acids, were strongly recommended by Dr Prout. On the other hand, alkalies might prove serviceable, if uric acid by conversion be the source of the oxalic acid. Both acids and alkalies may be administered alternately, to combat any tendency to an association of the two species of calculous concretion.

The prevention of *phosphatic* concretions relates especially to the *earthy* phosphates, the more common constituents of such calculi. The phosphates of lime and magnesia are deposited, in connection with an ammoniacal alkaline state of the urine, as depending on muco-purulent cystitis. Concretion is apt to form around some portion of pus or mucus, or a fragment of any stone left in the bladder after lithotrity or lithotomy. Hence the corrective use of acids is indicated, and particularly by injection into the bladder, as in the treatment of chronic cystitis.

No special preventive treatment is required for *cystine* concretion, which is comparatively rare, and any tendency to which will be counteracted by the measures appropriate for uric acid calculus.

Solvent Treatment.—The removal of a calculus by *solution* is a mode of *cure*, which has been attempted by either of two kinds of agents; by chemical solvent agents,—lithontriptics administered by the mouth, or by injection into the bladder; by electrolysis,—the transmission of an electric or galvanic current, for the dissolution of stone in the bladder.

(a) *Chemical* solvent agents comprise alkalies and acids. The former class of remedies may be employed for the removal of calculi, which are soluble in alkalies, *i.e.*, uric acid, urates, and cystine; the latter class, for those calculi which are soluble in acids, *i.e.*, oxalate of lime and phosphatic concretions. The mode of administration of either class of these remedies might be, by the mouth, or by injection into the bladder. Practically, however, the chemical solubility of urinary calculi, and the mode of attacking them, seems to amount to this; that uric acid calculi only, and allied concretions, are soluble by alkalies, and as administered by the mouth; phosphatic calculi only by acids, and by injection of the acid solution. Oxalate of lime calculi cannot be dissolved by any known solvent agent or method of administration.

It would appear also from Dr W. Roberts's original series of experiments and clinical observations, that *renal* calculi are more generally amenable to solvent treatment, than vesical calculi; of course, necessarily, by the internal method, or passage of the remedy through the kidneys.

The internal method is applicable for the solution of *vesical* calculi, according to the observations referred to, only in cases of uric acid calculus; where also the stone is not large, and the urine is acid.

Two rules should be observed in applying this solvent treatment; to keep the urine *continuously* alkaline, and to maintain this state to a certain *degree*. A solution of bicarbonate of potash, less in strength than

three grains to the pint of water, will have scarcely any greater effect than simple water.

The acetate and citrate of potash are the best salts for administration. Of the former, the dose for an adult should be from forty to sixty grains, in three or four ounces of water; for children, from twenty to thirty grains. The citrate is best prepared pure and of uniform strength from the crystallized bicarbonate of potash by the crystallized citric acid. Thus, the following prescription, recommended by Dr Roberts, yields a solution containing one drachm of the citrate in each fluid ounce :—

℞ Potass. Bicarb., ʒiij.
Acid. Citric., ʒviij, gr. xxiv.
Aque ad ʒxiij.

The dose for an adult is six to eight drachms, mixed with three or four ounces of water; for children, three to six drachms, diluted in the same proportion.

To fulfil both the rules laid down, the dose must be repeated at intervals of not less than every three hours during the day, taking a dose the last thing before going to bed, and another, if the patient be awake, in the night.

In conducting this treatment, the freshly voided urine should be frequently examined. If, at any time, it becomes ammoniacal, as denoted by the odour and muco-purulent deposit, the solvent treatment must be suspended. So long as the urine remains free from ammoniacal taint, when passed, there will be no risk of any deposition of the mixed phosphates encrusting the stone.

Injection.—The other method of applying solvent agents is restricted chiefly to calculi which are soluble in acids,—phosphatic calculi. Alkalies, administered by injection, have very little effect on uric acid calculi; and acids pass through the kidneys only in very small proportions.

The injection method of treatment is, however, somewhat in this dilemma; that the solution, if strong enough to have any useful effect, may endanger the coats of the bladder; and if sufficiently diluted to avoid this danger, any solvent action on the stone is very uncertain.

A weak solution of nitric acid,—two, or two and a half minims of the strong acid to the ounce of distilled water,—was used by Sir B. Brodie, for the solution of phosphatic calculi by injection; and with the result of greatly reducing the size of the stone, or even at length accomplishing its entire dissolution. A weak solution of acetate of lead,—one grain to the ounce, with a mere trace of free acid, was the preparation and strength employed by Dr Hoskins.

After *lithotrity*, injection may be used, as a solvent method of treatment, adjunctive to, or as a substitute for, the repeated operations of crushing fragments. The comparative merits of these two modes of procedure—the chemical solution, or mechanical crushing of stone in the bladder—must be determined by their relative speed and safety in effecting a cure. Good results have been obtained. Notably in a case by Mr Southam, of Manchester. After repeated lithotrity, fresh phosphatic concretions continued to form in the

bladder as fast as the old ones were crushed, so that the bladder could not be cleared. The mechanical operation having thus failed, an injection, containing two drachms of dilute nitric acid to a pint of water, was resorted to every day, or every second day. In the course of a short time, the old fragments were entirely dissolved, and the formation of new concretions prevented.

Injection may be performed through a double-current catheter, whereby a continuous stream of the solvent is made to act upon the stone.

(b) *Electrolysis*, or the dissolution of stone in the bladder by the transmission of an electric or galvanic current, has had its advocates. Sir W. B. O'Shaughnessy, Dr Bence Jones, Dr L. Melicher, and Gruithuisen, have severally attempted this method of treatment.

It will be seen that the foregoing methods of treating urinary calculi apply only to exceptional cases.

The *Surgical Operations* of Lithotritry and Lithotomy are fully considered in connection with **STONE IN THE BLADDER**.

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